



# **SURFACE WATER INVESTIGATION WORK PLAN**

**AUTO ION SITE  
KALAMAZOO MICHIGAN**

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**Prepared by:  
Conestoga-Rovers  
& Associates**

651 Colby Drive  
Waterloo, Ontario  
Canada N2V 1C2

Office: (519) 884-0510  
Fax: (519) 884-0525

web: <http://www.CRAworld.com>

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## 1.0 INTRODUCTION

This Surface Water Investigation Work Plan ("Work Plan") describes the sampling, analysis, and data assessment activities to be conducted to investigate conditions in the Kalamazoo River near the Auto Ion Site (Site) in Kalamazoo, Michigan. The Site location is shown on Figure 1.1.

The Work Plan was prepared by Conestoga-Rovers & Associates (CRA) on behalf of the Auto Ion Site group, pursuant to a request from United States Environmental Protection Agency (U.S. EPA) provided in a letter dated May 31, 2011, and subsequent technical discussions and correspondence.

### 1.1 BACKGROUND

The Remedial Investigation (RI) for the Site included investigation of surface water conditions in the Kalamazoo River, comprising collection and analysis of surface water samples from various points. In addition, a sediment toxicity study was conducted to evaluate conditions in the river bed adjacent to the site and potential impacts to biota. This led to the determination that there was no adverse effect on the river from Site groundwater, and that Alternate Concentration Limits (ACLs) should be developed for groundwater at on-Site point of compliance (POC) monitoring locations.

Two methods for ACL determination are documented in the Statement of Work incorporated into the Auto Ion Operable Unit 2 Consent Decree (SOW). The current selected ACL method (listed in the original SOW as the alternate method) is based on statistical analysis of groundwater concentrations for chemicals of concern (COCs) over eight quarters (1997 to 1999). On this basis, ACLs have been established for each parameter (at each point-of-compliance [POC] monitoring well), which reflect the (baseline) results from the first eight rounds of monitoring. The ACL method listed in the original SOW as the primary method, but now utilized as a step in the Contingency Plan, is based on surface water quality standards with consideration for mixing.

The current groundwater monitoring program for the Site was initiated in 1997. The current monitoring frequency is semi-annual (January and July of each year) and includes eight COCs i.e., arsenic, chromium, mercury, nickel, zinc, cyanide, trichloroethylene (TCE), and vinyl chloride. Groundwater monitoring has shown some confirmed ACL exceedances over time. Over the 5-year period from 2006 through 2010 there were no confirmed ACL exceedances at any shallow wells except arsenic and cyanide at MW-5B. Trend analysis for shallow monitoring wells indicates downward

or no trend for any parameters from 2006 to 2010. Over the same period the confirmed ACL exceedances at the deep monitoring wells primarily included arsenic, chromium, and nickel. Trend analysis for deep monitoring wells for the same period indicates some upward trends, primarily for arsenic and chromium, as well as downward or no trends for other COCs.

In the most recent agency Five Year Review (August 2011) U.S. EPA summarized the ACL exceedances and identified actions to evaluate the need to modify the Contingency Plan and to implement additional studies to assess river water quality. The U.S. EPA letter dated May 31, 2011 includes a request to conduct surface water sampling as reproduced below.

*"As an initial action, please develop a work plan to obtain and analyze surface water samples from the Kalamazoo River for use to support or refute the algorithm used to calculate impacts on the river, and then to perform model-to-observation comparison. The plan should include locations upstream, opposite, and downstream of the site; sampling at or near the groundwater-surface water interface; multiple sampling events that occur only when groundwater is discharging into the river; and sufficient analytical precision to allow comparisons between the sample data and algorithmic results."*

The algorithm noted above relates to calculations that are performed under certain circumstances when detected concentrations above ACLs are identified for a POC monitoring well. The calculations incorporate a value for the groundwater discharge rate and the river flow (1Q10 for acute effects and 7Q10 for chronic effects). As such, the calculated values represent the estimated concentrations within the river following mixing, based on specified river flow conditions.

## **1.2 PURPOSE AND OBJECTIVES**

The purpose of the sampling program is to further investigate surface water quality conditions due to agency concerns about variable groundwater concentration trends and the need to confirm the algorithm used to assess potential impacts from groundwater to the Kalamazoo River.

The overall requirement for the sampling program for the Site is to ensure that the Site continues to meet the criteria under Section 121(d)(2)(B)(ii) of CERCLA for the establishment of ACLs, including insuring that "there is no increase in contaminant concentration in surface water at the point of entry or at any point where there is reason

to believe accumulation of constituents may occur downstream". Under the SOW, any chemicals of concern migrating from groundwater to the Kalamazoo River are evaluated "after mixing in the Kalamazoo River". Because the Site has been determined to meet all criteria for establishing ACLs, "the attainment of all other Applicable or Relevant and Appropriate Requirements (ARARs) related to water quality criteria is not required." (EPA Response to Comment 5 in Responsiveness Summary attached to ROD).

Based on the results from monitoring activities undertaken to date, the overall requirements and goals of the monitoring program under the SOW, and U.S. EPA's requests for surface water sampling, water samples will be collected to characterize the river conditions, for several purposes, including:

1. To determine concentrations of COCs within the cross-section of the river (upstream, downstream, and adjacent to the Site)
2. To determine concentrations of COCs in the river near the groundwater- surface water interface, and within sediment pore water below the base of the river
3. To differentiate, if necessary, any impacts found in surface water relating to the Auto Ion site and/or other contaminant sources
4. To assess the algorithm used in the current monitoring program to evaluate groundwater impacts, if any, on the river
5. To consider whether modifications are needed to the current algorithm used to evaluate groundwater impacts, if any, on the river; the current ACL calculation methodology; and/or the current groundwater monitoring program
6. To address issues raised during the 5-year review process and facilitate decision-making as to whether improvements can be made to the current monitoring program, including data evaluations and ACL methodology

### **1.3 WORK PLAN ORGANIZATION**

The remaining sections of this work plan are organized as follows:

Section 2.0	Field Investigation Activities
Section 3.0	General Procedures
Section 4.0	Analytical Protocols
Section 5.0	Data Assessment and Reporting
Section 6.0	Quality Assurance Project Plan
Section 7.0	References

## 2.0 FIELD INVESTIGATION ACTIVITIES

### 2.1 OVERVIEW

The proposed field investigation includes the following components:

- A survey to identify the physical conditions of the river and potential zones of groundwater discharge into the river near the Site
- Collection and analysis of pore water samples from below the base of the river in identified groundwater discharge zones
- Collection and analysis of surface water samples from the base of the river at the same locations where pore water samples are collected
- Collection and analysis of surface water samples from transects across the full width of the river

Two survey/sampling ("monitoring") events will be conducted at least 3 months apart to assess possible temporal variations in groundwater discharge zones and water quality. The monitoring events will be conducted at the time of maximum expected differential between groundwater and surface water temperatures, i.e., summer or winter, in order to assist with identifying zones of groundwater discharge.

In addition, the sampling events will be targeted for times when low flow or "base flow" conditions are anticipated and when minimal or no rainfall precipitation is expected to occur. Hence, this is when river flow would reflect the maximum groundwater venting input (as a percent of total river flow), therefore reflecting the maximum potential impact on COC concentrations in the river. It is noted that the estimated groundwater discharge rate across the southern boundary of the Site is approximately 0.09 cubic feet per second (cfs), which is orders of magnitude lower than the 1Q10 (230 cfs) and 7Q10 (280 cfs) values for low flow in the Kalamazoo River in the Site vicinity.

The flow determination will be based on the United States Geological Survey (USGS) gauging station located approximately three miles upstream of the Site (USGS 04106000 Kalamazoo River at Comstock, MI). Prior to each monitoring event the gauging station data will be assessed to confirm low flow conditions. Before proceeding with sampling, water levels at the Site will be measured (piezometers and river) to confirm the groundwater levels are higher than the river water level.

The survey and subsequent sampling activities will be conducted by field technicians using a small flat bottom boat, supported by on-shore personnel to assist with

positioning the boat and other technical and safety support functions. Alternatively, survey locations in shallow water will be accessed by wading.

## **2.2 RIVER SURVEY AND SELECTION OF SAMPLE LOCATIONS**

The first monitoring event (tentatively scheduled for summer 2012) will include an initial survey of the river to investigate physical conditions and potential groundwater discharge points as follows:

- The depth to river bottom will be measured at various points along six transects across the full width of the river and additional points within the river (bounded by the north bank and the center of the river between the transect lines) as generally depicted on Figure 2.1.
- The location of each point will be recorded using GPS survey equipment. In addition, each location will be marked with temporary poles (and flagging) pushed into the river sediment, if possible, pending completion of the sampling event.
- The water temperature and conductivity will be measured through water column at same points as above (e.g., using <http://www.sontek.com/castaway> or other appropriate instrument).
- Push probes (e.g., graduated rod) will be used to determine penetration depth/presence of soft sediments at same points as above.
- A temperature probe will be used to determine temperature in pore water below river bed (e.g., using digi-sense thermistor or other appropriate instrument) at same points as above.
- Push probes with an open screen (e.g., Henry Push Point Sampler - PPS or other appropriate device) in the river bed at same points as above, connected to flexible tubing will be used to measure water elevation (head) of the screened interval of pore water relative to the river water surface. See Appendix A for information regarding the Henry Push Point Sampler.
- The conductivity of pore water (from the screen section) at same points as above will be measured by field instrument reading from an aliquot of water from the probe following "development" of the PPS by voiding sufficient water to produce a low turbidity sample.

As stated previously, the survey will be scheduled to occur during a period when minimal or no rainfall is expected and when low river flow is anticipated, in order to monitor conditions of expected groundwater gradient from the Site toward the river.



This will be confirmed by measuring groundwater levels and the river water level at the Mills Street Bridge and a temporary staff gage at the downstream Site boundary, prior to and during the monitoring event.

The survey information will be tabulated and provided to the agencies on an expedited basis, i.e., on a daily basis as the survey work is being conducted, and will be used to identify areas of potential groundwater discharge towards the Kalamazoo River. The indicators of potential groundwater discharge to the river include:

- Sequential decrease in head (elevation) from on-Site piezometers, to pore water (as measured within the push probe), to river (as measured outside the push probe)
- Differences in water temperature between pore water and river water, with the highest differences anticipated at times of high (summer) or low (winter) conditions
- Differences in conductivity readings between pore water and river water

The locations selected for pore water sampling and chemical analysis will be those that exhibit the strongest evidence of potential groundwater discharge into the river based on the head differential, temperature, and conductivity measurements. The selection of sample locations will also consider spatial representation of the study area. If the survey does not provide a clear indication of groundwater discharge zones, or if the results indicate recharge from the river to the groundwater, then alternative methods or postponement of sampling will be discussed with the agencies.

Subject to the identification of appropriate pore water sample locations based on the above assessment, sampling for chemical analysis will be initiated as soon as possible, e.g., within approximately 1 week after completion of the survey.

The sample locations for chemical analysis will include:

- Up to eight locations (to be confirmed based on river survey information) adjacent to and downstream of the Site, for collection of discrete pore water samples (assumed to be an approximate depth of 6 to 12 inches into the river bed) and surface water samples from the base of the river
- Two locations (to be confirmed based on river survey information) upstream of the Site, also for collection of discrete pore water samples and surface water samples from the base of the river
- Six surface water samples collected from each of six river transects, as indicated on Figure 2.1

Information for river flow conditions will be collected from the upstream USGS Comstock gauging station, as noted above, to assist with the overall data assessment.

The second monitoring event will be tentatively scheduled for late 2012, subject to weather and water level conditions. Based on the results of the first monitoring event and the assessment of groundwater flow direction (based on water level data collected during 2012), the survey procedures will be reviewed and adjustments will be made if necessary, subject to agency review and approval.

## **2.3        SAMPLING PROCEDURES**

### **2.3.1      PORE WATER SAMPLING**

The following procedures will be used for collection of pore water samples from push probes for chemical analysis:

- The sampling equipment will be decontaminated before use at each location as described in Section 3.2.
- The sampling sequence will proceed from downstream to upstream, to avoid potential effects of sampling activities on downstream locations.
- The sample location will be confirmed relative to the original survey location using GPS survey methods.
- At each location the push probe (e.g., Henry Push Point sampler or equivalent) will be advanced into the sediment to a depth of approximately 1 foot.
- Measurements of water level and temperature will be recorded using the same procedures used for the river survey.
- A syringe, or peristaltic pump (using dedicated syringes and/or tubing) will be used to void the device of its initial contents at a "low flow" rate (generally 50 to 200 millilitres per minute [mL/min]) until water free of turbidity is produced by the device. Water removed from the device will be released back to the river immediately downstream of the device.
- After initial purging pH and conductivity readings will be recorded and the sample containers will be filled in the following order: VOCs, metals, cyanide, hardness. [All of the pore water samples will be unfiltered.] See also the pre-sampling test requirements in Section 3.4.
- The push probe will be left in place until surface water sampling (base of river) is completed at each location as described in the following section.

### **2.3.2      SURFACE WATER SAMPLING - BASE OF RIVER**

At each location where a pore water sample is collected, a grab water sample will also be collected for chemical analysis from the base of the river as follows:

- The sampling equipment will be decontaminated before use at each location as described in Section 3.2.
- The grab water sample will be collected after the pore water sample has been collected at each location, while the push probe remains in place.
- The grab water sample will be collected from an area within approximately 1 foot of the push probe, perpendicular to the river flow direction (so as to not be directly downstream of the probe).
- The sampling device will be US-DH-81 sampler or equivalent. See Appendix B for surface water sampling equipment information.
- The grab water sample will be collected from a point immediately above the river bed (approximately 6 inches) by lowering the sample device quickly to the appropriate depth and allowing it to fill completely.
- The sampling device will then be raised and the contents will be transferred to sample containers in the following order: VOCs, metals, cyanide, hardness. [All of the base-of-river samples will be unfiltered, however an additional sample will be collected and field-filtered for analysis of chromium, nickel, and zinc to provide comparison to surface water quality that are based on dissolved conditions. Field-filtering will be conducted by passing the surface water from the sampling device through a 0.45 micron filter, then into the sample container.] See also the pre-sampling test requirements in Section 3.4.
- A separate aliquot will be used for measuring pH and conductivity.

### **2.3.3      SURFACE WATER SAMPLING - RIVER TRANSECTS**

Composite surface water samples will be collected at each transect, to represent overall water quality within the river as follows:

- The sampling equipment will be decontaminated before use at each transect location as described in Section 3.2.
- The sampling sequence will proceed from downstream to upstream.

- At each transect, "depth integrated" samples will be collected at equal width increments (EWI) as described in Chapter 4 of the National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water Resources Investigations, book 9.
- The cross sectional width of the river at each transect will be divided into ten equal width increments, from which a depth integrated sample will be obtained by descending and retrieving the sampler at a constant transit rate at the mid-point of each increment; samples will be composited in a US SS-1 Fluoropolymer "Churn" Sample Splitter. See Appendix B for surface water sampling equipment information.
- The sampling device will be USDH-81 Sampler or equivalent. See Appendix B for surface water sampling equipment information.
- Samples from each transect composite will be transferred from the churn splitter to sample containers in the following order: metals, cyanide, hardness. [All of the river transect samples will be unfiltered, however an additional sample will be collected and field-filtered for analysis of chromium, nickel, and zinc to provide comparison to surface water quality that are based on dissolved conditions. Field-filtering will be conducted by passing the surface water from the sampling device through a 0.45 micron filter, then into the sample container.] See also the pre-sampling test requirements in Section 3.4.
- A separate aliquot will be used for measuring pH and conductivity.

This method (river transect composite sampling) assures a sample for analysis which reflects the lateral and vertical variability of concentrations in the river water column which may be present due to inputs to the river that are not fully mixed, and produces a sample which is representative of concentrations in the entire cross section transect of the river.

VOC composite samples will not be collected from the river transects. Instead, a VOC grab sample will be collected through the full depth of the water column at the centroid of flow at each transect.

### 3.0 GENERAL PROCEDURES

#### 3.1 OVERVIEW

The field activities will be undertaken by experienced CRA field technicians directed by a CRA project manager, and working under the requirements of the approved work plan and a Site-specific Health and Safety Plan (HASP). During all field activities, field personnel will use appropriate personal protective equipment (PPE) according to the activities being conducted and the work conditions, and as required by the HASP.

During sampling activities, a new pair of disposable latex gloves will be used by each sampling team member at each sample location, and changed more frequently as needed to prevent cross-contamination. Additional information regarding equipment decontamination, field quality assurance/quality control procedures, sample handling and shipping, management of investigation-derived waste, and field documentation is provided below.

#### 3.2 EQUIPMENT DECONTAMINATION

The re-usable field equipment used for chemical sampling and requiring decontamination before initial use and following each use includes:

- Henry Push Point sampler
- Surface water grab and depth-integrating sampler (US DH-81A)
- Compositing vessel (churn splitter) for surface water samples (non-VOC parameters) from transects
- Equipment used for field filtering (excluding non-reusable filters)

The non-dedicated sampling equipment used for pore water sampling (Henry Push Point sampler) will be decontaminated with the following rinse sequence:

1. Wash with laboratory-grade detergent (e.g., Alconox), using a brush to remove any particulate or surface film
2. Rinse with potable water
3. Rinse with distilled or deionized water
4. Allow to air dry to the extent possible

The non-dedicated equipment for surface water sampling (certain US DH-81A sampler components and churn splitter) and the reusable field-filtering equipment will be decontaminated prior to use at each sampling location (i.e., each "grab" sample point and each transect) in the same manner as described above for the push point sampler. Additionally, the surface water sampling equipment will be "field rinsed" with the water source being sampled in accordance with the previously cited USGS Techniques of Water Resources Investigation Book 9.

Fluids used for cleaning will be replaced as necessary during use to avoid potential cross-contamination. All wash water, rinse water and decontamination fluids will be stored in separate containers at the Site pending final disposal.

### **3.3      FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

Field blank, field duplicate, trip blank, and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling program. The general level of the QC effort will be consistent with requirements for the Site groundwater monitoring program. This includes one field blank, one field duplicate, and one trip blank per sampling event or a minimum of one per ten investigative samples. One matrix spike/ matrix spike duplicate (MS/MSD) for organic analytes and one matrix spike/ matrix duplicate (MS/DUP) will be collected for inorganic analytes for every 20 or fewer investigative samples.

Field blank (rinsate) samples will consist of distilled or deionized water, with two types collected, one for pore water samples (poured through pre-cleaned push point sampler) and one for surface water samples (poured into and out of a pre-cleaned US DH-81A sampler). Field duplicate samples will be collected concurrently with original samples. One trip blank consisting of laboratory purified water will be prepared by the laboratory and included with each shipment for VOC analysis. MS/MSD and MS/DUP samples for organic and inorganic analyses are prepared from the investigative samples. MS/MSD water samples (for organic analysis) typically must be collected at double or triple the normal volume, while no additional volume is required MS/DUP samples (for inorganic analysis). The actual volumes will be in accordance with laboratory instructions.

Calibration of field instruments will be conducted at least daily during each sampling event. The field equipment will be maintained, calibrated and operated in a manner consistent with the manufacturer's guidelines.

### **3.4        SAMPLE HANDLING AND SHIPPING**

Sample handling and shipping procedures, including labeling, chain-of-custody, and shipping methods will be consistent with existing approved procedures used for groundwater sampling.

Table 3.1 presents information regarding sample containers, preservation, shipping, and packaging requirements for the water samples to be collected.

A "pre-sampling test" will be conducted to ensure that acid intended for sample preservation does not interact with water and effervesce. The pre-sampling test employed is field observation for evidence of effervescence (generation of gas phase substances) in the sample at the time it is combined with acid in the sample bottle. In the event there is evidence of effervescence, the sample bottle will be emptied, rinsed three times, filled with a new aliquot of sample, and submitted to the laboratory with information on the chain of custody form indicating it is not acidified (and maximum holding time is therefore reduced accordingly).

### **3.5        MANAGEMENT OF INVESTIGATION-DERIVED WASTE**

Investigation-derived waste (IDW) includes the following:

- Decontamination fluids
- Used PPE and sampling gloves

Each type of IDW listed above will be segregated, containerized, and temporarily stored on-Site pending disposal. Liquid waste will be stored in 55-gallon drums with sealed lids, and characterized to determine requirements for off-site disposal. Used PPE, sampling gloves, and other general waste (trash) will be collected in regular garbage bags and removed from the Site for disposal as non-hazardous municipal waste at completion of the sampling event or more frequently, as necessary.

### **3.6        DOCUMENTATION**

Field log books and sampling forms will be used by sampling personnel to document all field activities. Field log books will be bound documents with consecutively numbered pages. The entries for each day will commence on a new page which will be dated.

Corrections will be made by striking through the error with a single line, initialing and dating the strike-through, and entering the correct information.

The following information will be recorded in the field log book for each sample collected:

1. Site location identification
2. Unique sample identification number
3. Date and time (in 2400-hour time format) of sample collection
4. Weather conditions
5. Designation as to the type of sample (grab, composite, etc.)
6. Designation as to areas of collection (pore water, surface water)
7. Name of sampler
8. Analyses to be performed on the sample
9. Any other relevant comments such as sample appearance, filtering, preservation, etc.
10. Results of field analyses and measurements
11. Name of person performing field analyses and measurements

The field log books and any associated field sampling forms and documents will be maintained at CRA's offices.



## **4.0     ANALYTICAL PROTOCOLS**

### **4.1           SAMPLE ANALYSIS**

The analytical methods to be used for analysis of water samples and target quantitation limits (TQLs) for each analytical parameter are shown in Tables 4.1 and 4.2, respectively.

Pore water samples will be analyzed for select VOCs (TCE, vinyl chloride); select metals (arsenic, chromium, mercury, nickel, zinc); cyanide; and hardness.

Surface water samples collected from the base of river will be analyzed for select VOCs, select metals, cyanide and hardness. Field-filtered samples will also be analyzed for chromium, nickel, and zinc.

Composite surface water samples collected from each river transect will be analyzed for select metals, cyanide and hardness. Field-filtered samples will also be analyzed for chromium, nickel, and zinc.

The surface water grab sample collected at the centroid of flow of each transect will be analyzed for select VOCs.

### **4.2           DATA QUALITY ASSESSMENT**

Data quality assessment will be conducted as specified in the Quality Assurance Project Plan (CRA, 2001).

## 5.0 DATA ASSESSMENT AND REPORTING

CRA will compile all data obtained pursuant to the surface water investigation into a report to be submitted to the U.S. EPA and MDEQ. The report will include information regarding field activities, an assessment of the data, and associated conclusions and recommendations. The analytical results for the first sampling event will be provided in an interim submittal following data validation.

### Data Assessment

The assessment of analytical results for surface water samples and pore water samples will include:

- Comparison of results for upstream, mid-stream and downstream locations to identify differences in concentrations and assess the potential of Site-related impacts.
- Comparison of pore water results with groundwater data to identify differences in concentrations and assess potential Site-related impacts.
- Comparison of the pore water sample results and the corresponding surface water results from the base of the river to assess relative concentration differences.
- Review of results from the river transect composite samples relative to expected results due to groundwater mixing in the river (i.e., evaluation of expected river concentrations resulting from mass flux of substances in groundwater based upon concentrations measured in pore water).
- Comparison of pore water sample results to generic Groundwater -Surface water Interface (GSI) criteria established pursuant to Part 201 of Michigan 1994 PA 451 as amended. Mercury concentrations in pore water will be compared to the EPA method 245.1 target quantitation limit of 0.2 µg/L as recommended by the MDEQ Collaborative Stakeholder Initiative report of March 14, 2012. Data for pore water sampling locations which exceed the generic GSI values may also be evaluated by comparison to estimated "Mixing-Zone" based GSI criteria developed consistent with rules established for Part 31 of 1994 PA 451 as amended, and relevant guidance issued by MDEQ Remediation Division such as Operational Memoranda No. 1 and 5.
- Comparison of surface water sample cross-section transect results to federal and state surface water quality criteria (National Recommended Water Quality Criteria per Section 304a of the Clean Water Act and Michigan Rule 57 Water Quality Values established per Part 31 of 1994 PA 451 as amended) for applicable protected designated uses and incorporating relevant Site-specific information such as the hardness and pH of the Kalamazoo River surface water. Results of sampling of the

lower zone of the water column, although not representative of river conditions, will be reviewed to assist in understanding the nature of any "mixing-zone" and stratification of COCs in the river due to the Site.

The comparison of water sample analytical results as noted above will be used as a screening step to determine if further assessment is required. If the screening values are exceeded due to elevated levels of Site-related COCs that are not attributable to upstream conditions then the subsequent initial assessment will involve more detailed review of the analytical results. This will be based on ecological risk assessment procedures, considering site-specific information regarding potential ecological receptors and potential impairment of designated protected uses. The assessment will be conducted using procedures consistent with U.S. EPA guidance (Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, June 1997). The initial assessment will include a screening level ecological risk assessment, comprising Step 1 and Step 2 of the guidance. The screening level assessment will be used to determine whether further characterization of site conditions (e.g., surface water quality, benthic zone) is required, and the need for detailed risk assessment. This will be determined in accordance with the U.S. EPA Ecological Risk Assessment Guidance involving subsequent Steps (Step 3 and higher) described in the guidance.

In addition, the results of the investigation will be used to evaluate the algorithm that is included in the Contingency Plan and currently used to assess confirmed ACL exceedances. The assessment will be based on: the most recent groundwater concentration data available at the time that surface water sampling is conducted; the hydraulic gradient measured at the Site at the time of groundwater sampling and the time of surface water sampling; and the river flow information from the USGS Comstock gauging station at the time of surface water sampling. This information will be used to determine expected concentrations in surface water adjacent to the Site following mixing. This will be compared to the measured COC concentrations in river transect samples, with consideration of any upstream detections of COCs in surface water. The analytical results for the pore water and the base of river surface water samples will also be considered as intermediary points (with respect to COC transport from Site groundwater to the river) as part of this assessment. On the basis of the assessment, conclusions regarding the utility of the algorithm will be made, along with recommendations for adjustments to the algorithm, as appropriate.

Following the completion of the investigation and assessment activities described above, an overall review of the efficacy of the current monitoring and assessment procedures

will be undertaken. This may include the following activities, as appropriate based on the results of the assessment:

- Review of potential modifications to the groundwater monitoring program, to ensure that COC concentration trends and potential impacts on surface water quality are appropriately and effectively monitored
- Supplemental assessment and modeling of the interaction between COC concentrations in groundwater and surface water quality
- Review of the need for additional or continuing river monitoring, as a means of more direct assessment of potential effects of groundwater discharge from the Site

In conjunction with the above assessment(s), current U.S. EPA guidance and procedures for establishment of ACLs, and other relevant procedures for assessing potential impacts from groundwater to surface water will be reviewed, relative to the procedures being used for the Site. The method used for establishing existing ACLs is based on the baseline monitoring results from eight quarters of groundwater monitoring (Rounds 1 through 8) conducted from 1997 to 1999, and is premised on the determination that no adverse impacts to the river were observed during the RI/FS. Under this method, confirmed ACL exceedances do not infer an adverse impact on the river, they mean only that the measured groundwater concentration for a specific parameter in a specific monitoring well is statistically elevated relative to the baseline condition. The Contingency Plan contains procedures for assessing these occurrences to determine the likelihood of exceeding surface water quality criteria; however, the limitation of the current method is that the real significance of a confirmed ACL exceedance cannot be accurately determined.

If the results of the proposed river investigation do not indicate any significant Site-related impacts, and the current ACLs (based on data from Rounds 1 to 8) continue to be applied, then future groundwater monitoring is likely to show ACL exceedances which falsely indicate a potential river water quality issue. Using current procedures, this will result in unnecessary and non-beneficial use of technical resources. Therefore, if analytical results do not indicate any significant Site-related impacts to the river water quality then CRA will present recommendations to U.S. EPA for re-evaluation of ACLs, should it be determined that changes to the methods for establishing ACLs and evaluating compliance are necessary and appropriate. The ACL adjustment, if appropriate, will consider the existing methods for ACL establishment documented in the SOW and other methods as appropriate.

The general options that will be considered for ACL adjustments include, but are not limited to the following:

- Revised ACLs developed using existing procedures but calculated for a new baseline period, e.g., the most recent eight or more groundwater monitoring events
- Revised ACLs developed based on groundwater modeling and/or a mixing zone approach considering the rates of groundwater discharge and the river flow
- Alternate methods that incorporate river monitoring as a means of direct assessment of potential impacts of groundwater discharge to the river

The alternatives that are assembled will be assessed using relevant comparative criteria (e.g., technical effectiveness, implementability, reliability, cost, consistency with SOW requirements, and compliance with ARARs). The assessment and the recommended method for ACL adjustment, and proposed modifications to the Contingency Plan will be submitted to U.S. EPA for review and approval.

## 6.0 QUALITY ASSURANCE PROJECT PLAN

The agency-approved Quality Assurance Project Plan (QAPP) (CRA, 2001) includes details of the sampling and analytical procedures for the current groundwater monitoring program.

The QAPP includes the following elements:

1. Project description
2. Project organization and responsibility
3. Quality assurance objectives for measurement data
4. Sampling procedures
5. Sample custody and document control
6. Calibration procedures and frequency
7. Analytical procedures
8. Internal QC checks and frequency
9. Data reduction, validation, and reporting
10. Performance and system audits
11. Preventive maintenance
12. Specific routine procedures used to assess data precision, accuracy, and completeness
13. Corrective action
14. QA report to management

The work to be conducted related to the river investigation - sampling and analysis will be consistent with the QAPP requirements.

## 7.0 REFERENCES

CRA, 2001. Quality Assurance Project Plan – Part D, RD Work Plan for Operable Unit 2, August 1997, and amendments, May 2001.

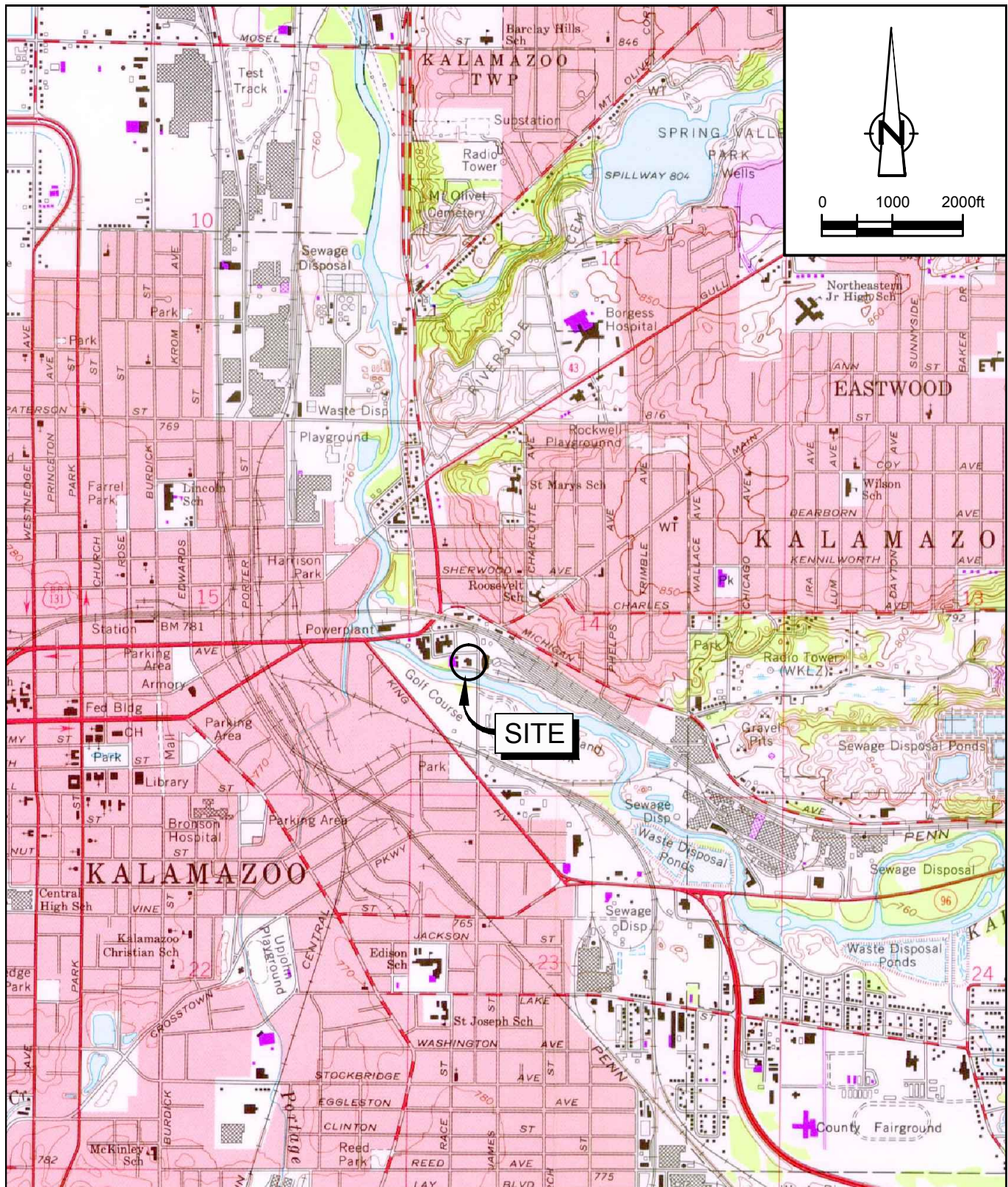
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. Environmental Protection Agency – Office of Solid Waste and Emergency Response, Edition 3, November 1986 and promulgated updates (SW-846).

USGS National Field Manual for Collection of Water Quality Data (TWRI book 9, Chapter A4), revised 2006.

([http://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4\\_v2.pdf](http://water.usgs.gov/owq/FieldManual/chapter4/pdf/Chap4_v2.pdf))

U.S. EPA, 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, June 1997.





SOURCE: USGS QUADRANGLE MAP;  
KALAMAZOO, MICHIGAN



figure 1.1  
SITE LOCATION  
AUTO ION SITE  
*Kalamazoo, Michigan*





Source: Imagery City of Kalamazoo 2011; Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet

figure 2.1

# Legend

- Monitoring Well
- Piezometer
- Transect
- River Bank (Approximate)
- Fenceline
- Road
- Sidewalk
- River Survey Area (~25 foot spacing)
- River Survey Area (~50 foot spacing)



RIVER SURVEY AND TRANSECT LOCATIONS  
AUTO ION SITE  
Kalamazoo, Michigan



TABLE 3.1

**SAMPLE CONTAINER, PRESERVATION, HOLDING TIME, FILLING, SHIPPING, AND PACKAGING REQUIREMENTS  
AUTO ION SITE  
KALAMAZOO, MICHIGAN**

<i>Analyses</i>	<i>Sample Containers (1)</i>	<i>Preservation</i>	<i>Maximum Holding Time from Sample Collection (2)</i>	<i>Volume of Sample</i>	<i>Shipping</i>	<i>Normal Packaging</i>
<b>WATER</b>						
Select VOC	Three 40-mL teflon-lined septum vials per analysis	HCl to pH < 2 Iced, 4 ± 2° C	14 days for analysis	Fill completely, no air bubbles	Courier	Foam Liner or Bubble Pack
Select Metals	One 1-liter plastic bottle	HNO <sub>3</sub> to pH < 2 Iced, 4 ± 2° C	180 days for analysis	Fill to neck of bottle	Courier	Bubble Pack
Mercury	One 1-liter plastic bottle	HNO <sub>3</sub> to pH < 2 Iced, 4 ± 2° C	28 days for analysis	Fill to neck of bottle	Courier	Bubble Pack
Total Cyanide	One 1-liter plastic bottle	NaOH to pH>12 Iced, 4 ± 2° C	14 days for analysis	Fill to neck of bottle	Courier	Bubble Pack
Hardness	One 250-mL plastic bottle	HNO <sub>3</sub> to pH < 2 Iced, 4 ± 2° C	180 days for analysis	Fill to neck of bottle	Courier	Bubble Pack

## Notes:

- (1) Multiple parameters on a single sample may not require separate additional containers for each parameter.
- (2) These are technical holding times, i.e., are based on time elapsed from time of sample collection.

TABLE 4.1

**SUMMARY OF ANALYTICAL METHODS  
AUTO ION SITE  
KALAMAZOO, MICHIGAN**

<i>Parameter (1)</i>	<i>Preparation Method (2)</i>	<i>Laboratory Preparation SOP</i>	<i>Analytical Method (2)</i>	<i>Laboratory Analytical SOP</i>
<b><u>Water Sampling</u></b>				
Select VOC	SW-846 5030B	NC-MS-019	SW-846 8260B	NC-MS-019
Inorganics				
Arsenic	SW-846 3010A	NC-IP-011	SW-846 6020	NC-MT-0002
Chromium	SW-846 3010A	NC-IP-011	SW-846 6020	NC-MT-0002
Mercury	EPA-WW 245.1	NC-MT-014	EPA-WW 245.1	NC-MT-014
Nickel	SW-846 3010A	NC-IP-011	SW-846 6020	NC-MT-0002
Zinc	SW-846 3010A	NC-IP-011	SW-846 6020	NC-MT-0002
Cyanide (total)	SW-846 9012A	NC-WC-0032	SW-846 9012A	NC-WC-0032
General Chemistry				
Hardness	SM 2340 C	NC-WC-036	SM 2340 C	NC-WC-036

## Notes:

- (1) Parameter  
VOC - Volatile Organic Compounds  
Select VOCs include Trichloroethene (TCE) and Vinyl chloride
- (2) Method References:
- SW-846 - "Test Methods For Evaluating Solid Wastes, Physical/Chemical Methods", SW-846, 3rd Edition and Promulgated Updates, November 1986.
  - EPA-WW - "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, Revised March 1983.
  - SM - "Standard Methods for the Examination of Water and Wastewater", 19th Edition, 1995.

**TABLE 4.2**  
**TARGETED QUANTITATION LIMITS (TQLS)**  
**AUTO ION SITE**  
**KALAMAZOO, MICHIGAN**

<i>Compound</i>	<i>Targeted (1)</i>
	<u><i>Quantitation Limits</i></u> <i>Water</i> <i>(µg/L)</i>
<i>Volatile Organic Compounds (VOC)</i>	
Trichloroethene	1
Vinyl chloride	1
<i>Inorganics</i>	
Arsenic	5
Chromium	2
Mercury(2)	0.2
Nickel	2
Zinc	20
Cyanide (total)	5
<i>General Chemistry</i>	
Hardness	5,000

## Notes:

- (1) Please note that these are targeted quantitation limits. Actual quantitation limits are highly matrix dependent. Target quantitation limits presented are for guidance only. Targeted quantitation limits may be effected by matrix interferences, QA/QC problems and high concentrations of target and non-target analytes.
- (2) The method cited for mercury analysis (EPA - WW 245.1) will be used to achieve a quantitation limit of 0.2 µg/L consistent with the recommendation and action level specified in the MDEQ Remediation Division Collaborative Stakeholders Final Report and Recommendations of March 14, 2012.

## APPENDIX A

### HENRY PUSH POINT SAMPLER TECHNICAL INFORMATION

MHE Products    PushPoint Sampler (US Pat. # 6,470,967)  
Operators Manual and Applications Guide

Ver. 2.01

2/15/03

Models: PP27, PP14, PPX36, PPX72

## Introduction

The groundwater/surface water interface (GSI) has been a research interest of mine for the past decade. This transitional zone is usually rich in biomass and may play a predominant role in the bioattenuation of contaminated groundwater entering surface water bodies. Usually these biologic processes have limited effectiveness in attenuating highly contaminated groundwater, leaving a plume of parent contamination and metabolic byproducts that eventually expresses itself in receiving waters - usually classified as non-point sources of pollution because of the uncertainty of the discharge area. Part of the problem in the detection and study of these plumes is that there were no devices on the market for the rapid, discrete collection of pore water samples. Reliance on conventional technology and techniques to perform a detailed investigation required extensive effort and burdensome equipment.

Through several iterations, I have evolved a simple device for collecting pore water samples from beneath surface water bodies or the beach areas surrounding them. Pore-water sampling using the PushPoint becomes a simple and efficient process, generating a wealth of information and very little waste. If one collects groundwater samples in a transect perpendicular to groundwater flow in the suspected area of plume discharge to an open water body, their analysis yields information about the aerial extent of contaminant discharge to the water body. At this point, additional sampling can complement the initial data and provide the information necessary to map the plume expression in both magnitude and aerial distribution. This is becoming increasingly important to regulators as they decide the ecological impacts of discharging contaminant plumes.

Sampling at each location usually takes 5 minutes, allowing a small crew to collect dozens of samples in an afternoon. These samples can be analyzed in the field for real-time information useful in directing field investigations and research. The work that I have conducted at several contamination sites indicates that many groundwater plumes discharge in surface water bodies in 2-3' of water depth - accessible to investigators wearing hip boots or waders. Many plumes, especially Light Non-Aqueous Phase Liquid (LNAPL) plumes can be delineated by collection of samples in very shallow water or from under beaches. My initial experience has shown that Dense Non-Aqueous Phase Liquid (DNAPL) contaminant plumes express themselves in the shallow, near-shore water as well, even though the on-shore depth of the contaminant mass was deep in the aquifer.

## Directions

Look at Figure 1.

As you can see, the PushPoint device is a very simple, precisely machined tool consisting of a tubular body fashioned with a screened zone at one end and a sampling port at the other. The bore of the PushPoint body is fitted with a guard-rod that gives structural support to the PushPoint and prevents plugging and deformation of the screened zone during insertion into sediments. The PushPoint is made of 316 stainless steel assuring compatibility with most sampling environments. The screened-zone consists of a series of interlaced machined slots which form a short screened-zone with approximately 20% open area.

Operation of the device is not difficult. One simply holds the device in a manner that squeezes the two handles towards each other to maintain the guard-rod fully inserted in the PushPoint body during the insertion process (as shown in Figure 2). Holding the device in this manner, push the PushPoint into the

sediments or beach to the desired depth using a gentle twisting motion. When the desired depth is reached (or you hit refusal, usually at an aquitard) remove the guard-rod from the PushPoint body without disturbing the position of the deployed sampler. Once the guard-rod has been removed from the PushPoint, it **SHOULD NOT** be reinserted into the device until the bore of the PushPoint has been thoroughly cleansed of all sand, silt, etc.

Attach a syringe or peristaltic pump to the PushPoint sample-port (see Figure 3) and withdraw water at a low-flow sampling rate (50-200 ml/min.). The first 20-50 ml of groundwater will be turbid. This is the "development" water and should be discarded. Once non-turbid aliquots have been withdrawn, representative samples can be collected for on-site and off-site analysis.

## Cleaning and Maintenance

I cannot stress how important cleanliness and linearity are to the working life of the instrument. The PushPoint was designed as an indefinitely reusable device; potentially able to be reused hundreds of times. The tolerance between the guard-rod and the bore of the PushPoint is very small. Increases in this tolerance through abrasion and damage may allow silty material into this annular space, eventually jamming the guard-rod into the bore - maybe permanently!

Excess wear and abrasion can also be introduced if the guard-rod is inserted frequently when the PushPoint body is bent. All the small bends should be "undone" prior to reinsertion of guard-rod to avoid scraping the sides of the bore causing burrs. Before reinsertion of the guard-rod into the cleaned PushPoint, the device should be "straight as an arrow". Use caution when straightening the screened-zone, it is somewhat delicate without the guard-rod inside it, and can be broken through repeated bending. Similarly, the guard-rod should be bend-free and clean when inserted into the bore of the device. When a clean and straight PushPoint is assembled, the guard-rod should slide fairly easily through the PushPoint bore and its handle should seat against the sampling port.

Clean the exterior of the guard-rod and PushPoint body and screened-zone with a stiff brush and cleaning solution (soapy water). Cleaning and decontamination of the bore of the instrument is easily accomplished using the cleaning adapter provided. Remove the spray nozzle of a "garden sprayer" filled with cleaning solution. Connect the adapter as shown in Figure 4. Insert the sampling port of the PushPoint to the adapter and squirt ~ 100 ml of pressurized cleaning solution backwards through the sampler and out the screened-zone into a waste receptacle. Gently push the guard rod into the bore of the PushPoint to its end to dislodge any bridged material. Re-rinse the bore with cleaning solution. Follow this with a distilled water and/or methanol rinse. Reinsert the guard-rod and the device is ready to be used again.

In some instances it may be advantageous to force the cleaning solution through the screened-zone and out the sampling port. To do so, gently insert the screened-zone of the PushPoint into the cleaning adapter, making sure not to bend the screened-zone, until the entire screened-zone is within the adapter. The screened-zone is somewhat fragile. To avoid damage, do not bend the screen-zone during insertion into the adapter. Squirt cleaning solution through the sampler to a waste receptacle.

## Helpful Hints, Information, and Cautions

- Multiple depths can be sampled in one hole if samples are collected, in order, from deepest to shallowest. Insert the sampler using a twisting motion until you reach refusal. Remove the guard-rod. **Do not push the sampler further into the sediments once the guard-rod has been removed as this may damage the screened-zone and plug the device with sediment.** Once sampling has been completed at this deepest depth, the PushPoint can be partially pulled from the hole to a new sampling

elevation. Remember, to prevent screened-zone damage, do not to insert the PushPoint into the sediments without the guard-rod inserted into the PushPoint body. Alternately, multiple holes can be used to collect samples from multiple depths at a particular sampling location. If vertical sampling is performed in one hole, it is recommended that some type of device such as a sampling platform be used to prevent lateral movement and slippage of the PushPoint as sampling is conducted near the top of the hole (see Figure 3). This offsets the leverage of the instrument and reduces hole degeneration. A simple platform would be a plate of steel with a 3/16" dia. hole through its center and would serve the fundamental purpose of maintaining a rigid hole opening. MHE offers a 8" dia., heavy-duty steel sampling platform engineered for the precise sampling depth requirements of field research. If repeated shallow sampling is to be conducted, it may be more convenient to use a shorter sampler (i.e. MHE - PP14").

- If you wish to reuse the PushPoint sampler at a particular sampling location and want to clean the bore quickly while you're there so that the guard-rod may be safely reinserted, you can use a syringe filled with surface water or DI water to backflush the bore several times before reinserting the guard-rod. Use at least 100 ml of water. If you have too much trouble reinserting the guard-rod (i.e. grit), it will be necessary to use the standard cleaning procedures.
- If the screened-zone of the PushPoint becomes plugged while inserted in the sediments due to passage through "something", it is frequently possible to hydraulically/pneumatically shock the screened-zone free of adhering material while it is inserted into the sediments. Attach a large-volume (50 ml) syringe to the sampling port. In a quick motion, pull the syringe plunger most of the way back (creating a vacuum) and then immediately release the plunger - the plunger will slam to a neutral position, sending a shock wave through the bore of the PushPoint and may alleviate the problem.
- The PushPoint can be used as a piezometer to determine the static head of the groundwater and hence, the potential direction of groundwater movement. To do this, a tube is connected to the sample port as shown in Figure 5. A continuous stream of water is established from the syringe (or pump) to the screened-zone by pumping out any air remaining in the PushPoint /tubing. When the tube is disconnected from syringe, the static water level in the tube will represent the static water level at the depth that the screened-zone occupies. In some discharge areas I have found several feet of head differential, and when the tubing is removed, the PushPoint flows like a miniature artesian well.
- It is frequently possible to push the PushPoint through thin lenses of low-permeability material and collect samples from below them and gather valuable geochemical samples. At many of the sites where the PushPoint has been used, sampling from just below a layer of fine sand/silt/clay, one occasionally encounters seemingly large pockets of gas that seem to have coalesced and collected under this less permeable stratum. Analysis of these pockets may provide additional insight to predominant biological processes. It is likely true that the concentration of volatile chemicals in the groundwater has equilibrated with these bubbles which means that their presence in a sampling stream or syringe would not significantly affect the concentration of dissolved volatile organic chemicals (VOC's). In fact, if one assumes that equilibrium conditions exist, the concentration of VOC's in the bubbles is directly related to the concentration in the surrounding groundwater. A different condition may exist if the groundwater is supersaturated with bacterial metabolic waste gases and the negative pressure exerted by the pump (or syringe) initiates degassing of dissolved gases from the groundwater. In this instance, VOC's would partition from the groundwater to the bubbles as they are formed in the sampling tubing (this is fairly evident if occurring). The consequence of this condition is that part of the dissolved contaminant mass has partitioned into the gas phase and unless the gas-phase is captured, quantified and accounted for, the native VOC concentration of the groundwater is not reflected by analysis of the groundwater alone. If this condition exists, the degassing effect can be minimized by decreasing the sampling rate to a rate more easily yielded by the sampled formation. With experience, it is easy to distinguish which of these conditions (or combination of conditions) exist and to what extent they affect sample quality.
- The internal volume of a PushPoint PP27 is approx. 1.5 ml. A 50 ml syringe full of distilled water, deion water, methanol, etc. will push about 33 volumes through the bore.
- When straightening the screened zone it is sometimes helpful to flush out the bore of the device with a cleaning solution and then insert the guard-rod to the area of the bend in the screened-zone. Gently unbend the portion of the screened-zone nearest the rod and carefully advance the rod to the next bend.



After the rod has been fully inserted into the screened-zone perform the final screened-zone, straightening until the guard-rod slides freely through it.

- If the sampling port of the PushPoint is above the static level of the water body, each time you remove the syringe or pump from the PushPoint sampling port, air will fill the bore of the PushPoint, allowing the water level in the bore to reach its static head. To avoid this plug of air from entering the subsequent syringe, attach a pinch clamp and/or a 3-way valve between the sampling port and the syringe or pump inlet as shown in Figure 7.
- I have conducted dye tests (concentrated uranine dye) by injecting concentrated dye under a perforated 1.5' diameter disk through which the PushPoint was inserted from depths of 3" - 12" into sediments. The goal of these tests was to determine whether or not surface water and dye are drawn into samples collected in near surface sediments (i.e. whether a cone of depression is formed). The results indicated that no surface water is drawn into samples even though sampling was conducted with a peristaltic pump at its maximum rate of 600 ml/min for several minutes.
- I usually couple my field investigations with global positioning system (GPS) identification of the sampling location. If conditions permit, a pin flag can be placed at the sampling location for later location by GPS - I usually use sub-meter grade GPS for this surveying. GPS can then be used in the future to relocate previously sampled location even if certain site physical characteristics have changed (eroding shorelines, etc.). If long-term study of a shoreline is planned it will be useful to have an elevation benchmark established on shore that can be used as a reference. The elevation of the sampling locations can then be accurately measured. This may be helpful in areas where sediment levels are not stable such as in erosional areas.
- Sampling by syringe has many advantages. This is my preferred field method due to its simplicity and versatility. It is useful to be able to collect several 50 ml syringes full of groundwater, store them on ice and perform the sample transfer to VOA vial, etc. under more controlled conditions. To transfer sample to a VOA vial, place the end of the transfer tube (Figure 8) to the bottom of the VOA vial. Dispense sample into the VOA vial and slowly withdraw the transfer tube from the vial maintaining the mouth of the transfer tube just below the sample surface. When the transfer tube is almost out of the vial, continue to dispense sample and leave an "anti-meniscus" of sample above the rim of the vial. Add several drops of HCl (which will displace a few drops of sample) and cap. If VOC samples are to be collected and/or stored temporarily in a syringe, I recommend 100% polyethylene/polypropylene ("two piece") syringes such as those made by Henke Sass Wolf GMBH (NormJect ®, 50 ml) configured as shown in Figure 8. From personal experience I have found that small amounts of aromatic compounds (BTEX) can leach from the rubber parts of the rubber-tipped plunger found in common medical syringes. Rubber-tipped plunger syringes have less side-wall resistance and work much smoother than the 100% polyethylene/polypropylene syringes so I use medical syringes for "development" of the PushPoint. Standard medical syringes also work well for collecting samples for non-VOC analysis. I utilize handheld meters for pH, conductivity, redox, DO, etc. One can dispense sample from the syringe into these types of instruments for field measurements. The disposable syringes may be cleaned and reused several times, but because they are a friction fit; prolonged reuse results in scoring of the barrel which eventually causes air leaks.
- The 50 ml, 100% polyethylene/polypropylene "two piece" syringes mentioned above can be purchased directly from MHE, configured with tubing, clamp, and stopper as was the example syringe included with your order, or customized to suit your individual needs. If you would like to make your own, the syringes that I am currently using are purchased from National Scientific. The tubing is Tygon 1/4"OD x 1/8" ID. Be sure to use some type of clamp at the tubing mouth to ensure a good seal at the sampler port. The entire syringe assemblies are now available from MHE at a reasonable cost.
- Headspace GC analysis of VOC's can be easily accomplished using 100% polyethylene/polypropylene syringes. Dispense all but 25 ml of the sampled groundwater from the syringe. Refill the syringe to the 50 ml mark with ambient air and then stopper the tubing (and heat the syringe in a water bath if desired) as shown in Figure 9. Shake the syringe assembly to equilibrate the VOC's in the sample with the contained atmosphere. Insert a GC syringe needle through the transfer tube into the sample syringe headspace and withdraw a sample for GC analysis.
- Occasionally a small amount of sand and silt is withdrawn into the syringe or pump sampling stream, even after proper "development" of the PushPoint. This may be due to the nature of the geologic formation. This fine material is probably already at equilibrium with the surrounding groundwater and

tests have shown that its presence should not influence analysis of VOC's in the groundwater sample. The sample can be transferred to its shipping container without this silt if the syringe is dispensed in such a manner as to let the solid material settle out in the syringe and not carry over to the shipping vial.

- The PushPoint has been used very successfully for underwater investigations using SCUBA equipment and a series of 100% polyethylene syringes. Once again, GPS equipment was used for location of the position that the divers collected groundwater samples of contaminant plume expression in the lake. Underwater notes (temperature, depth, observations, etc.) can be written directly on the sample syringes if they are pre-prepared with a strip of Scotch Magic Transparent Tape applied down the syringe body and writing is done with a soft pencil.
- The PushPoint may be used to inject nutrients or dyes into the sediments for field trials of biologic or geochemical testing or tracing groundwater paths. Simply insert the PushPoint to the desired depth, and after the guard-rod has been removed, connect a syringe or pump and slowly inject the desired fluid into the sediments, perhaps followed by a small amount of native groundwater to flush the instrument.
- The PushPoint is constructed of 316 stainless steel as mentioned previously. There are two places where the stainless parts are silver soldered together, the handle of the guard-rod and the handle on the PushPoint sampler. If the investigator is collecting samples for metals analysis, the silver solder joint on the guard-rod may impart trace levels metallic residue to the sampling port mouth. This has never caused a problem but the possibility exists. The silver solder that I use is Safety-Silv 45 which contains silver (45%), copper (30%), and zinc (25%). MSDS available upon request. In the unlikely event that these metals cause contamination of samples, MHE can produce specialty guard-rods that are not silver soldered. What can I say, these devices were originally built to sample for VOC's.
- These devices can be dedicated as semi-permanent underwater monitoring devices. If a PushPoint is inserted to the desired depth through a plate (such as the sampling platform mentioned earlier) that can lock the sampler at the correct insertion depth, a vinyl cap can be placed over the mouth of the sampler, and the sampler can be dedicated to that location so that future samples can be withdrawn when desired.
- It has been useful to carry several samplers in "quivers" made of 2" PVC tubing....one tube for (10-15) clean/assembled samplers and one tube for used samplers and their separated guard-rods. This arrangement protects both the investigators and the instruments.
- I have been using a Myron 6P Ultrameter available from [www.ColeParmer.com](http://www.ColeParmer.com) for most of my work. This instrument measures pH, specific conductance, ORP, temperature, and TDS using only a few milliliters of sample and is perfectly suited to samples dispensed by syringe. The instrument is waterproof to 3 m. There will soon be a link on the [MHEproducts.com](http://MHEproducts.com) web page.
- I have been using the Chemetrics Vacu-Vial technique ([www.Chemetrics.com](http://www.Chemetrics.com)) in conjunction with Pushpoint sampling. I use this for dissolved oxygen and dissolved iron measurements. Many other analytical tests are also available such as nitrate, phenols, etc.. This analytical technique also works very well with samples collected in syringes. The sample is dispensed into a plastic cone until it overflows. The tip of an evacuated ampoule containing the necessary reagents is broken off at the bottom of the cone allowing the vacuum in the ampoule to pull in a aliquot of sample that has not contacted the atmosphere. The ampoule is shaken and is then placed as a cuvette into a handheld spectrophotometer. The results are nearly instantaneous and are displayed in ppm. There will soon be a link on the [MHEproducts.com](http://MHEproducts.com) web page.

I hope that users will find many useful and innovative uses for this device. If you have other helpful information, uses, and advice concerning these samplers, please write or e-mail suggestions to me for inclusion in future manual revisions. I have finally started a web site: [www.MHEproducts.com](http://www.MHEproducts.com) and have posted pictures, new products, and the latest version of this manual.

Thanks. MHE

MHE Products  
3371 Sherman Rd.  
East Tawas, MI 48730  
USA

Phn: 989 362 5179  
517 393 0948

e-mail: [sales@MHEProducts.com](mailto:sales@MHEProducts.com)

# Figure 1

the PushPoint sampler

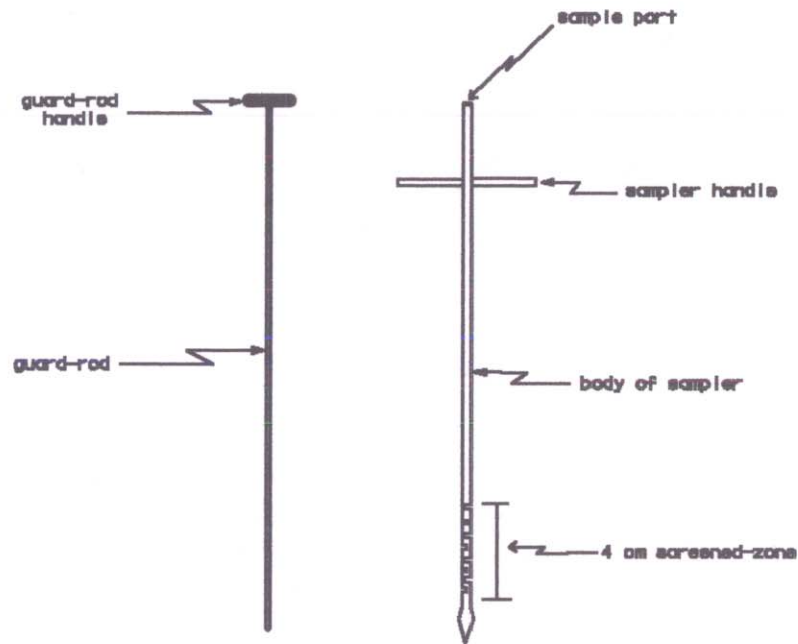


Fig. 1a  
disassembled sampler

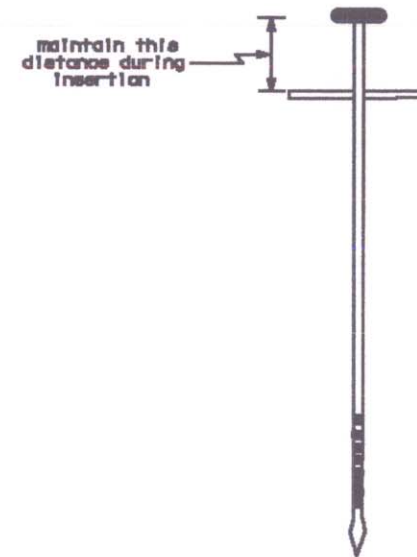
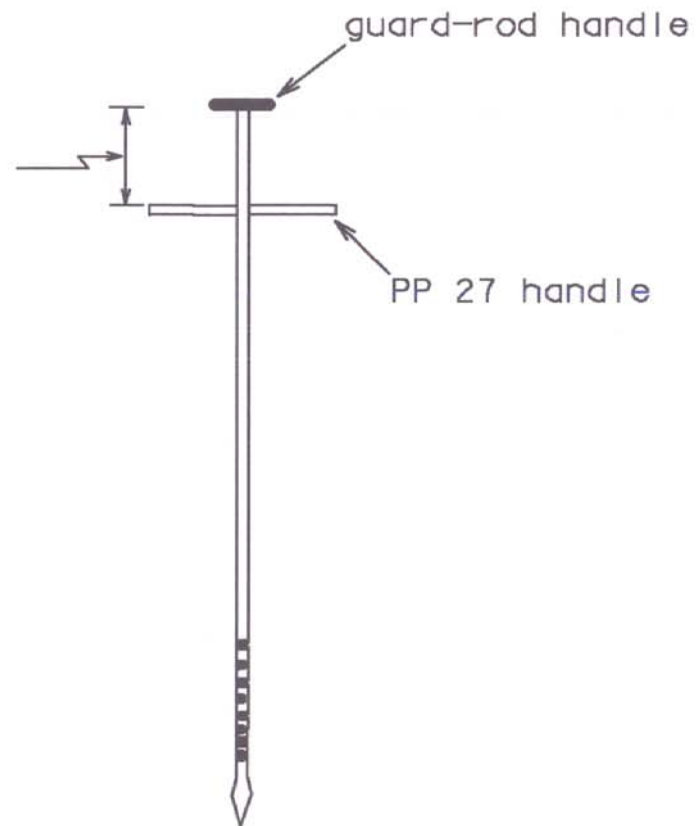


Fig. 1b  
assembled sampler

# Figure 2

grasp instrument firmly  
and squeeze two handles  
together to maintain  
this distance while  
inserting into sediments



# Figure 3

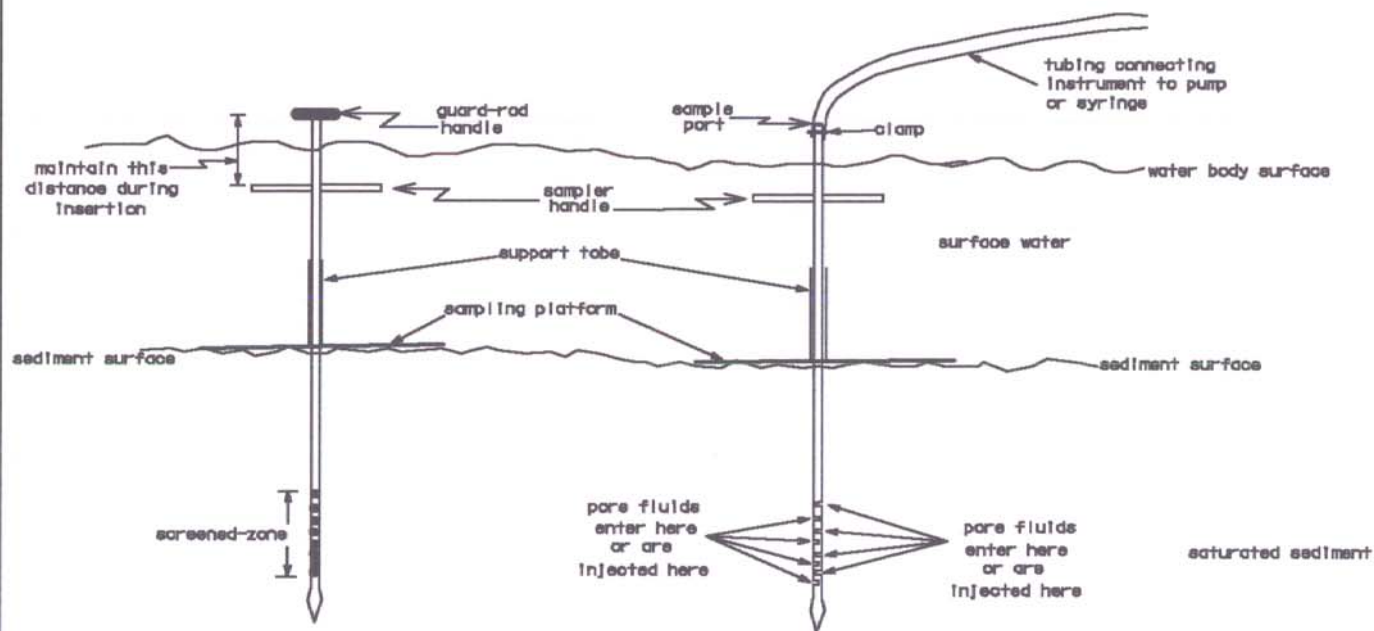
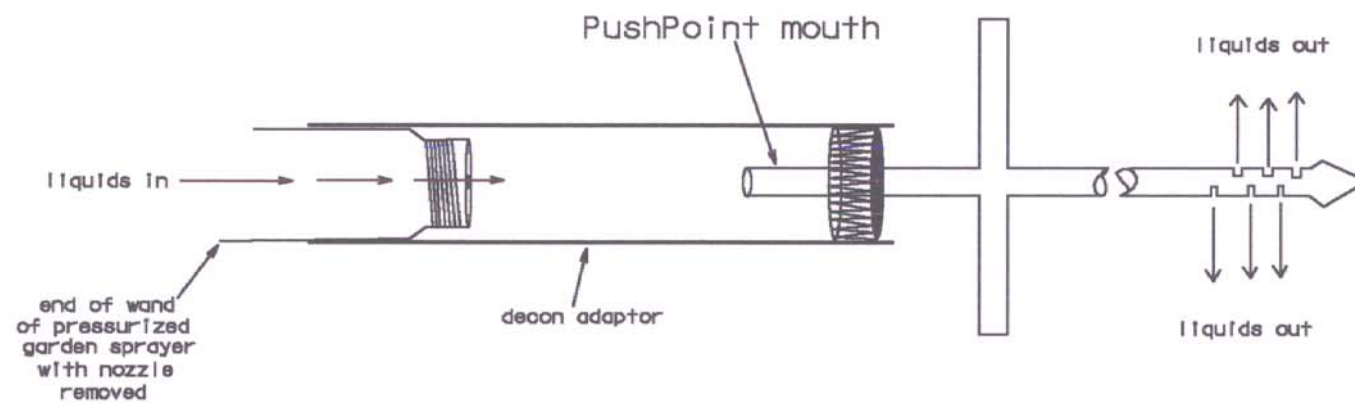


Fig. 3a  
configuration when  
installing in sediments

Fig. 3b  
configuration while  
sampling groundwater

# Figure 4

attachment of decon adaptor



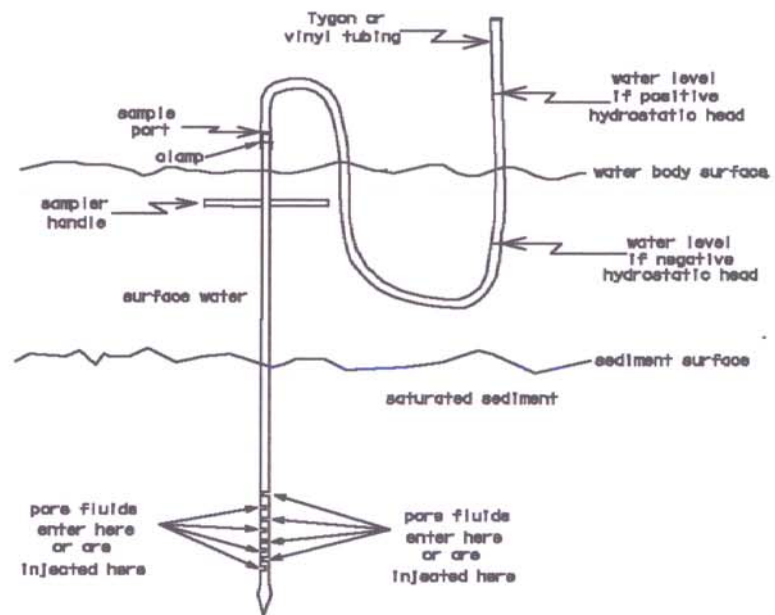


Figure 5



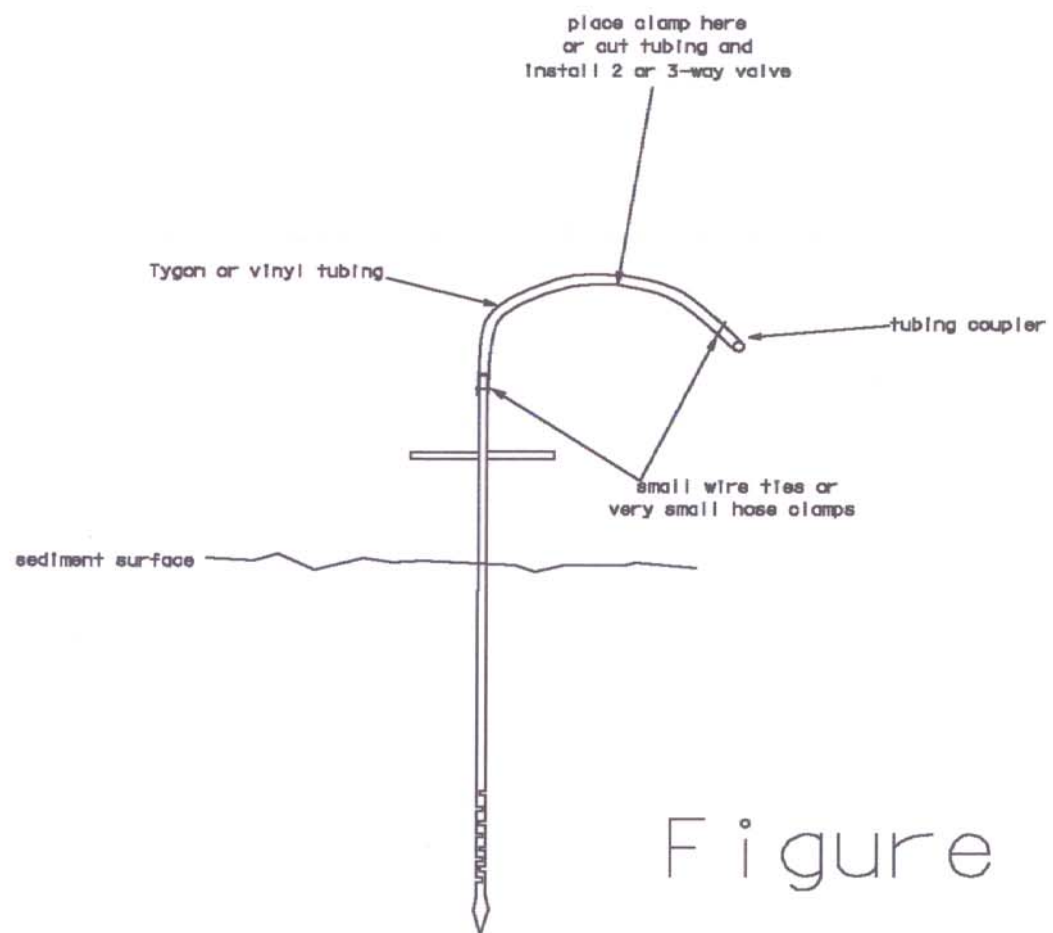
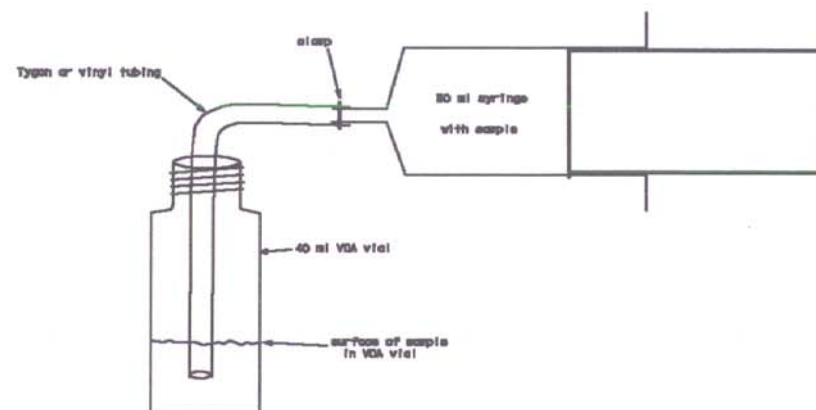


Figure 6

dispensing sample  
into VOA vial



sample in VOA vial  
awaiting preservation  
and capping

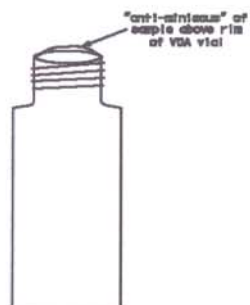


Figure 7  
filling VOA vial "headspace free"

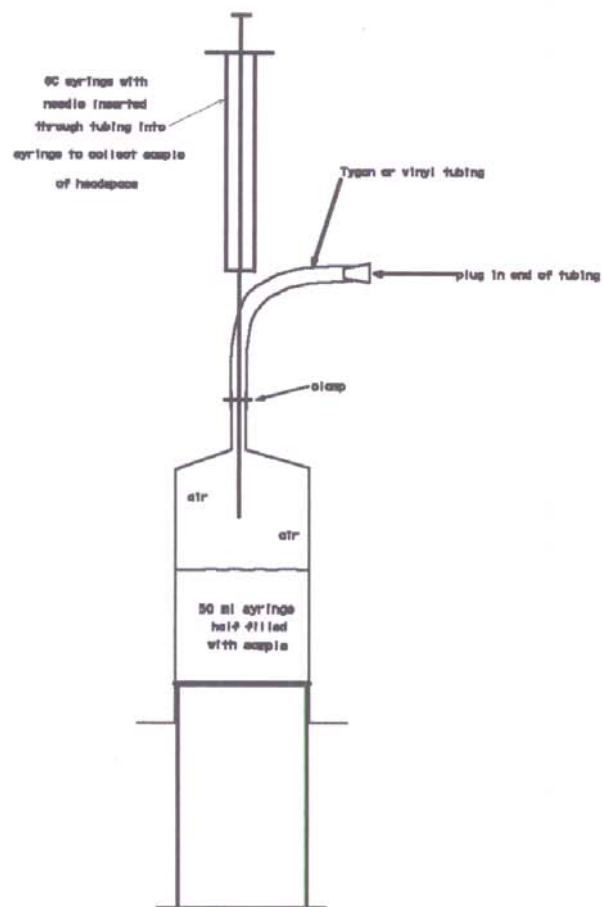


Figure 8

## APPENDIX B

### SURFACE WATER SAMPLING EQUIPMENT TECHNICAL INFORMATION

## **APPENDIX B**

### **SURFACE WATER SAMPLING EQUIPMENT TECHNICAL INFORMATION**

#### **US DH-81 Depth integrating suspended hand line sampler**

<http://water.usgs.gov/fisp/products/4107002.html>

See also enclosed Operator's Manual

#### **SS-1 CHURN SAMPLE SPLITTER, 14L**

<http://water.usgs.gov/fisp/products/4111002.html>

# Operator's Manual for the US DH-81 Depth-Integrating Suspended-Sediment Sampler

## Characteristics

**Description:** The US DH-81 is not a specific sampler in the sense of other Federal Interagency Sedimentation Project (FISP) depth-integrating suspended-sediment samplers. The US DH-81A is a plastic adapter with a threaded insert, which accepts a 1/2-inch (in) wading rod and is used with a variety of caps, nozzles, and containers to assemble a hand-held sediment sampler designated as the US DH-81. The US DH-81A will accept a plastic or perfluoroalkoxy (PFA) US D-77 cap or a US D-95™ Cap which is made of tetrafluoroethylene (TFE). The US D-77 cap is threaded to accept any container with Mason jar threads. The US D-95™ Cap is threaded to accept a 1-liter (L) fluorinated ethylene propylene (FEP) bottle. US D-77 plastic and TFE nozzles with internal diameters of 3/16, 1/4, and 5/16 in can be used with the US D-77 and US D-95™ Caps. The stainless steel wading rod used with the US DH-81A is available with or without a covering of plastic heat-shrink tubing to help prevent contamination of samples for trace metal analysis in water-quality sampling. An assembled US DH-81 sampler is shown in figure 1.

**Container:** US D-77 caps are threaded to accept any container with Mason jar threads, including containers with volume capacities up to several liters and containers made of glass. However, FISP only recommends the use of plastic or FEP 1-L bottles in the US DH-81 sampler. The sampler is difficult to use with large volume containers such as a 3-L bottle. The difficulty is in trying to submerge such a large volume of air by hand. Doing so is analogous to pushing a soccer ball underwater by hand. Maintaining a correct transit rate with the large volume container is difficult due to the compression rate of the large air volume. Use of a large volume container with the US DH-81 sampler results in a large unsampled zone compared with the 1-L bottle, which is especially important in shallow wadable streams. FISP recommends that glass containers not be used with the US DH-81 sampler. The container is completely unprotected in a US DH-81 and glass containers break easily when accidentally mishandled in streams with rocks and cobbles. If a glass container must be used, extreme caution should be exercised when touching the stream bottom during a transit.

Several cap/bottle combinations can be used to configure a US DH-81 sampler (figure 2). The 1-L plastic bottle has Mason jar threads and may be used with either the plastic or PFA US D-77 cap. Normally a plastic bottle would not be used with a PFA cap. However, in the event that a user had a PFA cap in hand and needed to take samples that did not require the use of the more expensive FEP bottle, a plastic bottle could be used. Use of a 1-L FEP bottle with a PFA US D-77 cap requires a 1-L bottle adapter (figure 3) because the FEP bottle does not have Mason jar threads. However, the US D-95™ Cap is designed to accept the 1-L FEP bottle directly. If use of a US DH-81 sampler is required for a sampling program, the user may contact FISP to determine the appropriate combination, especially if some of the parts are already in-hand. Table 1 presents cap/bottle combinations. Table 2 gives FISP part numbers for US DH-81 sampler equipment parts.

**Sampler function:** When the sampler is submerged with the nozzle pointing into the flow, the water-sediment mixture flows through the nozzle into the bottle, forcing air to exhaust through the air vent hole in the cap. A continuous stream filament is discharged into the sample container during the entire time of submergence.

## Limitations

**Velocity limitations:** The US DH-81 sampler will collect flow-weighted samples at acceptable inflow efficiency in stream velocities from 2.0 to 6.2 feet per second (ft/sec) with a 3/16-in nozzle, 1.5 to 7.6 ft/sec with a 1/4-in nozzle, and 2.0 to 7.0 ft/sec with a 5/16-in nozzle. Inflow efficiency is defined as the ratio of the water-sediment velocity entering the nozzle to the ambient stream velocity. An inflow efficiency of 1.0 is referred to as isokinetic. An acceptable inflow efficiency has been determined to be 0.9 to 1.1.

**Volume limitation:** Although the US DH-81 sampler uses a 1-L bottle, it is recommended that the sample volume collected not exceed approximately 800 milliliters (mL). The nozzle is horizontal when the sampler is in the stream collecting a sample. If the sampler is filled to approximately 1-L, the level of the sample in the container is near the bottom of the nozzle. If the rear of the nozzle becomes submerged by the water in the sample container, the inflow velocity will be reduced and the sediment concentration may no longer reflect the ambient suspended-sediment concentration.

**Depth limitation:** Based on the recommended maximum volume of 800 mL, the US DH-81 sampler will collect flow-weighted samples to a maximum recommended depth of 12 feet (ft) at sea level. The sampler can be used to a depth of 15 ft at sea level by collecting up to 1-L of sample. To sample to depths greater than can be waded, wading rod extensions in 1- and 3-ft lengths can be added to the sampler. With the extensions, the sampler can be deployed from a low bridge or boat.

A maximum safe wading depth depends on the size of the user, the stream velocity, and the streambed material. Each user should know and strictly adhere to his/her personal wading limitation. A wading factor can be determined by multiplying the depth (ft) of the stream by the stream velocity (ft/sec). As a general guide, a stream condition that produces a factor of 10 or greater should not be waded. Caution should always be used when wading streams deeper than 3 ft. Additional caution should be used when the streambed is composed of loose or slippery material. Algae-coated cobbles can be as slippery and as dangerous as ice. A personal flotation device should always be worn when wading (USGS WRD Memo 99.32). Additional safety information on wading is available in S.R. Abt, et. al., Human Stability in a High Flood Hazard Zone, American Water Resources Association, Water Resources Bulletin, V.25, no. 4, 1989, pp. 881-889.

**Unsampled zone:** The unsampled zone is the distance between the nozzle and the streambed at the lowest point to which the sampler is lowered. If the sampler is allowed to touch the streambed, the unsampled zone is the distance between the nozzle and the bottom of the sampler,

which in the case of the US DH-81 sampler is the bottom of the container. The unsampled zone for the US DH-81 sampler with a 1-L bottle is approximately 4 in. The unsampled zone for other containers must be determined by the user.

**Transit rate limitation:** The transit rate ( $R_t$ ) is the speed of lowering and raising the sampler in the stream vertical. Transit rate diagrams for various combinations of the US DH-81 sampler are presented in figures 4-12. The dark blue shaded area shows the transit rate for the recommended volume of 800 mL, and the light blue shaded area shows the transit rate for the maximum acceptable volume of 1000 mL. Table 3 gives the filling time to collect 800 mL of sample at various velocities using the three available nozzle intake diameters. The following factors should be considered when selecting a transit rate:

1.  $R_t$  must be fast enough so the bottle is not overfilled.
2.  $R_t$  must be slow enough to obtain a sample of sufficient volume for analysis.
3.  $R_t$  must not exceed the approach angle limit (0.4 times the mean stream velocity).
4.  $R_t$  must be slow enough to not exceed the compression rate limit.

### **Instruction for use of the US DH-81 sampler**

**Cap modification:** US D-77 plastic and PFA caps are molded with four locking “lugs” on the outside of the rear of the cap (figure 13). The lugs are located at the 12:00, 3:00, 6:00, and 9:00 o’clock positions. The top lug (12:00 o’clock position) must be removed before the cap will fit into the US DH-81A. FISP removes the lug prior to shipment to a user. However, some caps that have the top lug may be still in the field. If so, it must be removed prior to use in the US DH-81A. It can be removed easily with a utility knife.

In 1994, the US D-77 cap mold was modified so that four longitudinal “ribs” are molded on the angled face of the cap and are located at the 12:00, 3:00, 6:00, and 9:00 o’clock positions (figure 13). All four ribs on the angled face of the plastic cap must be removed prior to use in the US DH-81A. The ribs should not be removed from the PFA cap prior to use in the US DH-81A. These modifications are required because of the difference in shrinkage between plastic and PFA in the molding process. PFA shrinks more than plastic, so the ribs are needed to ensure that the PFA cap is tightly secured in the US DH-81A. The plastic cap does not need the ribs to be secured properly. FISP removes the ribs on plastic caps before shipment to a user. However, if the user has a plastic cap that has the ribs, they must be removed prior to use in the US DH-81A. The ribs can be removed with a utility knife. PFA caps molded prior to 1994 that do not have the ribs on the angled face require other modifications prior to use in the US DH-81A. FISP should be contacted for proper modification instructions for these early production caps.

The US D-95™ Cap requires no modification prior to use in the US DH-81A.

**Inspection:** The cap should be inspected for proper lug and rib configuration. The vent hole (figure 13) should be clear and unobstructed. The user should never make modifications to the vent hole. The threads in the nozzle hole should be checked for stripping and obstructions. The



threads can be chased with a 9/16-18 NF threading tap. The cap should be checked for cracks. A cracked cap should be discarded.

The US DH-81A should be checked for cracks. A damaged part should be discarded. The threaded aluminum insert that accepts the wading rod should be inspected. Damaged threads can be chased with a 3/8-20 NS threading tap. The US DH-81A should never be acid rinsed. Doing so will lead to corrosion of the metal insert.

Nozzles should be inspected for any visible damage. Nozzles with any deformation around the intake should be discarded. The nozzle bore should be checked for any burrs or roughness. Nozzles with bore damage should be discarded. The threads on the nozzle should be checked for damage. Damaged threads can be chased with a 9/16-18 NF threading die. Plastic nozzles should not be used when an acid rinse is required in the sampling protocol. Use only TFE nozzles when an acid rinse is required. All plastic US D-77 nozzles produced after May 2000 have a red identification ring.

The wading rod and any wading rod extensions should be checked for damage to the screw threads. If damaged, the threads can be chased with a 3/8-20 NS threading die. The female threads of wading rod extensions can be chased with a 3/8-20 NS threading tap. Attempting to mate a wading rod with damaged threads to a US DH-81A can damage the threads in the aluminum insert in the US DH-81A (figure 14). Plastic coated wading rods and extensions should be checked for damage to the plastic coating. Damaged coverings should be replaced with high quality 1/2-in diameter clear heat shrink tubing.

**Sampler assembly:** The selected cap should be inserted into the US DH-81A. The US DH-81A is designed with three semi-circular slots (figure 14) in the rear that accepts the three locking lugs on the cap. The cap will fit into the US DH-81A only one way. Once inserted, the cap should be rotated clockwise (viewed from the rear) until it is firmly seated. When correctly assembled, the vent hole in the cap should be in line with the wading rod receptacle. The nozzle can now be threaded into the cap. It should be hand-tightened only. Pliers or wrenches should not be used, as they may damage the nozzle. The wading rod and any extensions are subsequently attached. Lastly, the appropriate bottle is threaded into the cap.

**Sampling:** Detailed instructions for suspended-sediment sampling are contained in Edwards and Glysson's Field Methods for Measurement of Fluvial Sediment, Techniques of Water-Resources Investigations of the US Geological Survey, Book 3 Applications of Hydraulics Chapter C2, 1999, pages 35-70. Detailed instructions for water-quality sampling are contained in the National Field Manual for the Collection of Water-Quality Data, Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 9, Chapter A4, Collection of Water Samples, 1999, pages 25-48. Prior to collecting a sample, measure or estimate the mean velocity at each stream vertical. When using the equal-discharge-increment (EDI) technique, an approximately equal volume of sample should be collected at each stream vertical if the samples are composited prior to analysis. A transit rate can be determined from the information presented in table 3. First, locate the velocity in the first column of the table; then find the corresponding time to collect 800 mL of sample for the nozzle size being used. To determine the transit rate, multiply

the stream depth at the sampling vertical by 2 and divide by the sampling time. The result is the transit rate in ft/sec.

Example:

Mean velocity in the sampling vertical = 4.0 ft/sec  
Sampling time for 3/16-in nozzle = 37 (sec Table 3)  
Depth at sampling vertical = 3.0 ft  
Transit rate =  $2 \times (3 \text{ ft}) \div (37 \text{ sec}) = 0.16 \text{ ft/sec}$

With the EDI method, the transit rate at each vertical will be dependent upon the depth and mean velocity at that vertical. To determine a transit rate for a volume less than 800 mL, divide 800 by the desired volume, then multiply the transit rate as determined for 800 mL. For the above example, the transit rate to collect 400 mL would be  $800 \div 400 \times 0.16$  or 0.32 ft/sec.

Sampling using the Equal-Width-Increment (EWI) method requires the user to maintain a consistent transit rate in every vertical in the stream cross-section. The user should determine the mean stream velocity and the deepest sampling depth in the cross-section. Find the transit rate diagram for the container and nozzle being used. Apply the velocity and depth information to determine a proper transit rate.

Example:

Mean stream velocity = 3 ft/sec  
Maximum depth in sampling vertical = 2.5 ft  
Container: 1-liter plastic  
Nozzle: 3/16 in diameter plastic  
Use transit rate diagram in figure 5  
Find 2.5 ft depth on Y-axis, move horizontally to middle of “Recommended” zone  
Move vertically to intersect the X-axis and read the “Transit Rate Divided by Mean Velocity”, 0.1 for this example  
Multiply 0.1 times the mean velocity,  $0.1 \times 3 \text{ ft/sec} = 0.3 \text{ ft/sec}$   
The transit rate is 0.3 ft/sec and should be maintained at every vertical

When wading a stream to collect a sample, the user should minimize flow resistance and maximize stability. By turning sideways, the force of the water against the body that would push the user downstream can be minimized. Slightly bending the upstream knee and leaning into the flow will increase stability. The sampler should be held away from the body and as far upstream as possible. The wading rod should be held vertically with the sampler nozzle horizontal and pointing upstream. Figure 15 shows a proper position for sampling. Begin the transit with the sampler above the surface of the stream using the predetermined transit rate. Maintain the transit rate until the sampler container touches bottom, then immediately reverse the direction of the transit and maintain the transit rate until the sampler clears the surface. Care should be taken when touching the stream bottom so as not to disturb loose sediment and bias the sample. Once the sampler clears the surface, the user should be careful not to tilt the sampler forward so that the nozzle tilts down. If the container is nearly full, water could run out of the container back through the nozzle and bias the sample.

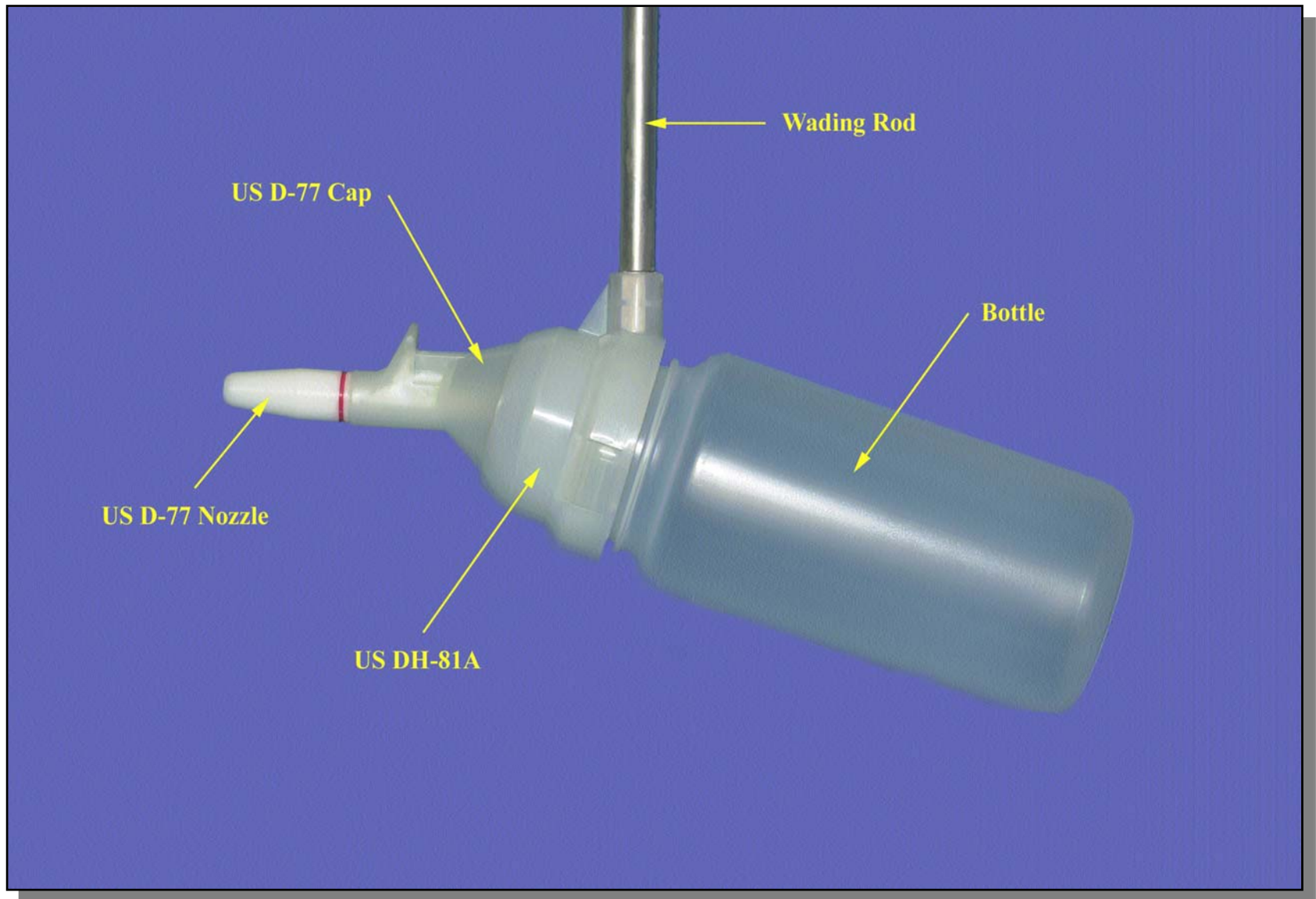
Upon completion of sampling with a particular container, remove it by firmly holding the cap with one hand and removing the container with the other hand. The wading rod may be secured under the user's arm, or rested on the user's shoulder during the operation. When collecting water-quality samples, the 2-person, clean-hands/dirty hands sampling technique should be used as described in the National Field Manual for Collection of Water-Quality Data, Chapter A4, pages 17-18. Cap and label the container. Each sample container label should contain adequate information. For sediment sampling, the following information should be considered:

- Name of stream
- Location of cross-section
- Location of vertical
- Stream depth covered by sample
- Stage of stream
- Date
- Time
- Identification of personnel
- Sampling time
- Water temperature
- Coordination with sample groups
- Serial number of sample

Appropriate documentation should be made for water-quality samples.

**Questions and comments regarding sampler operation should be addressed to:**

FEDERAL INTERAGENCY SEDIMENTATION PROJECT  
Waterways Experiment Station  
3909 Halls Ferry Road  
Vicksburg, MS 39180-6199  
(601) 634-2721  
[woneal@usgs.gov](mailto:woneal@usgs.gov)

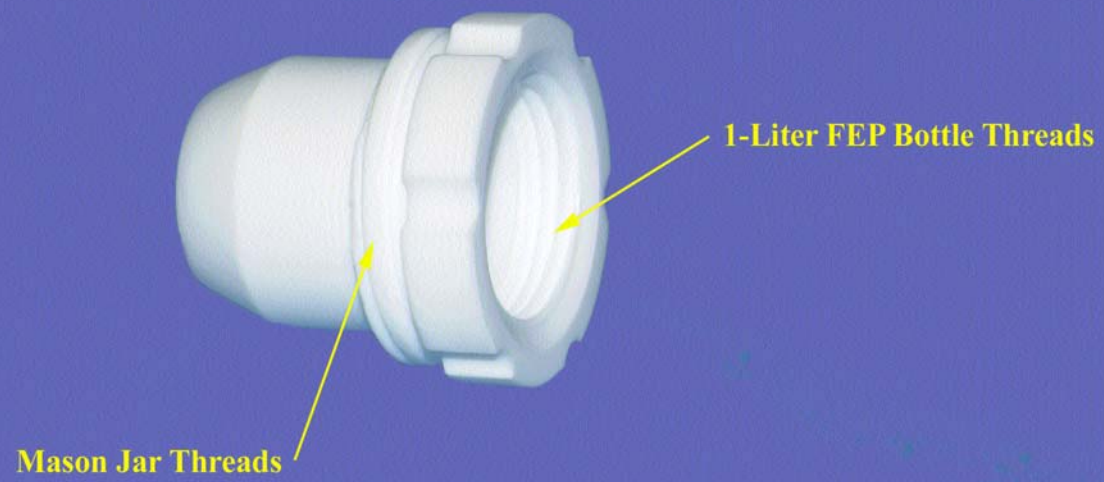


*Figure 1. US DH-81 sampler*

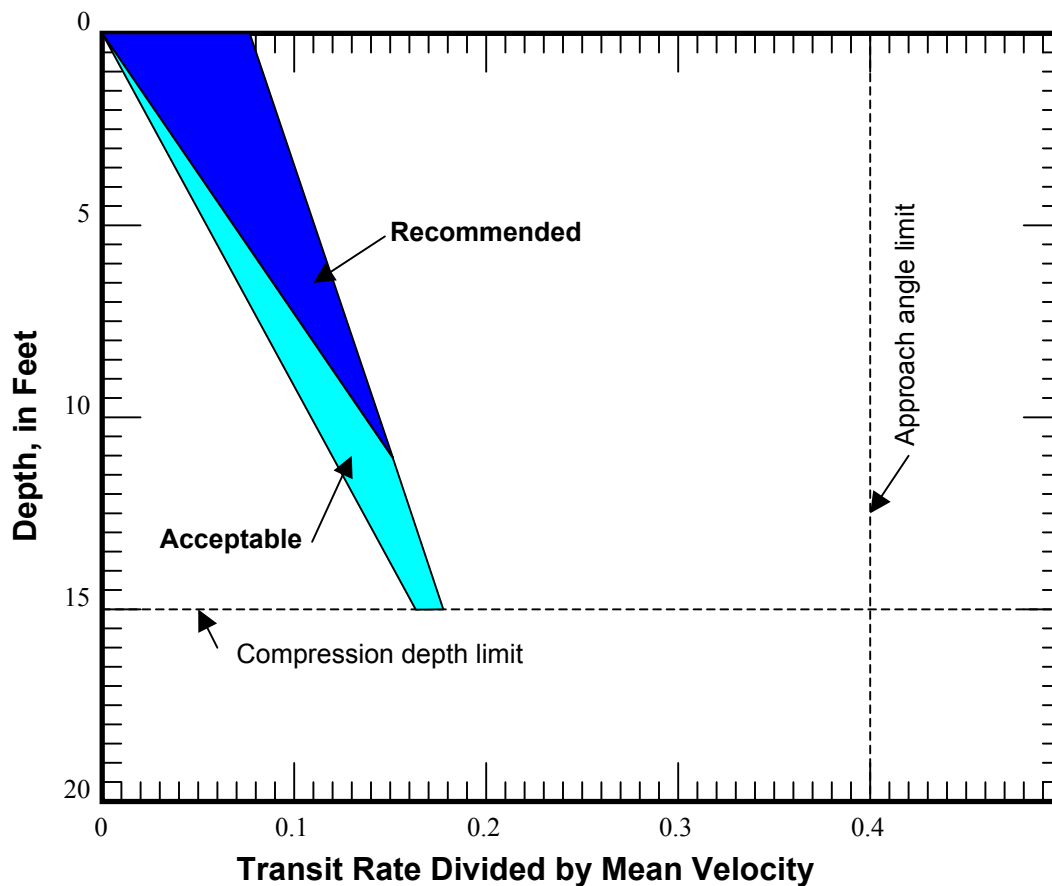


*Figure 2. US DH-81 sampler cap/bottle combinations*



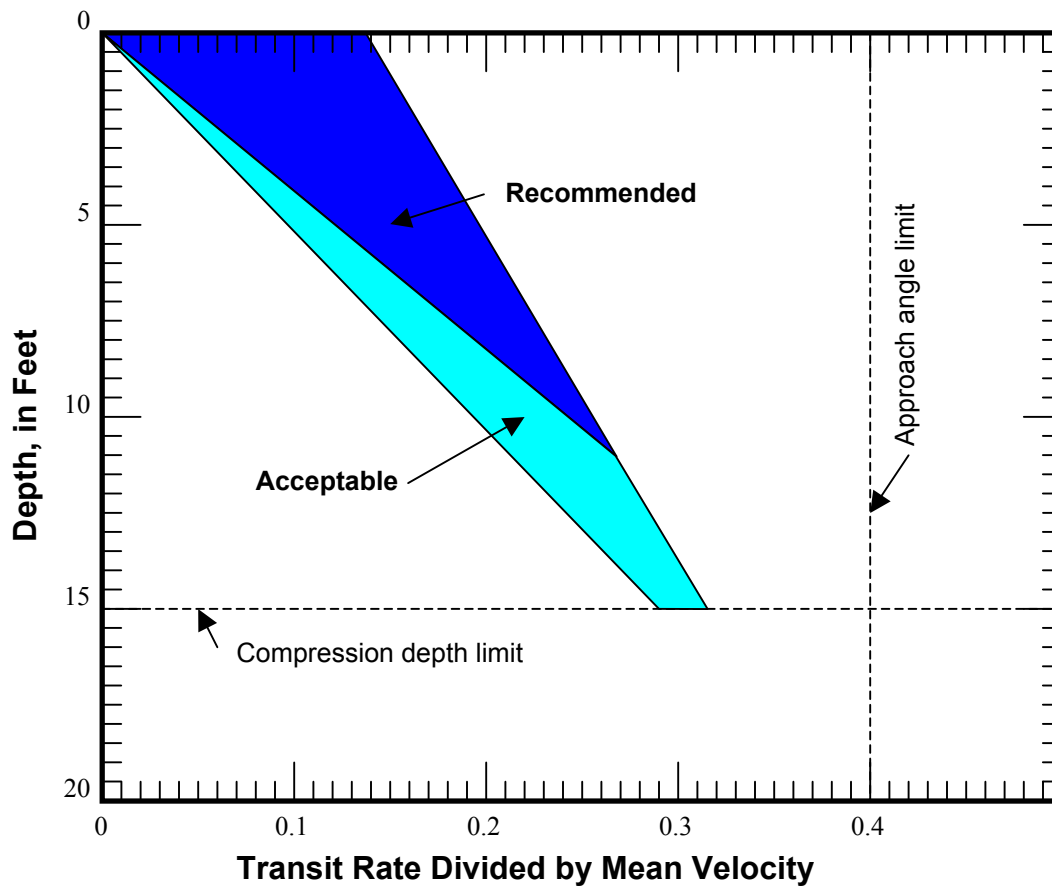


*Figure 3. One liter TFE bottle adapter*



Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

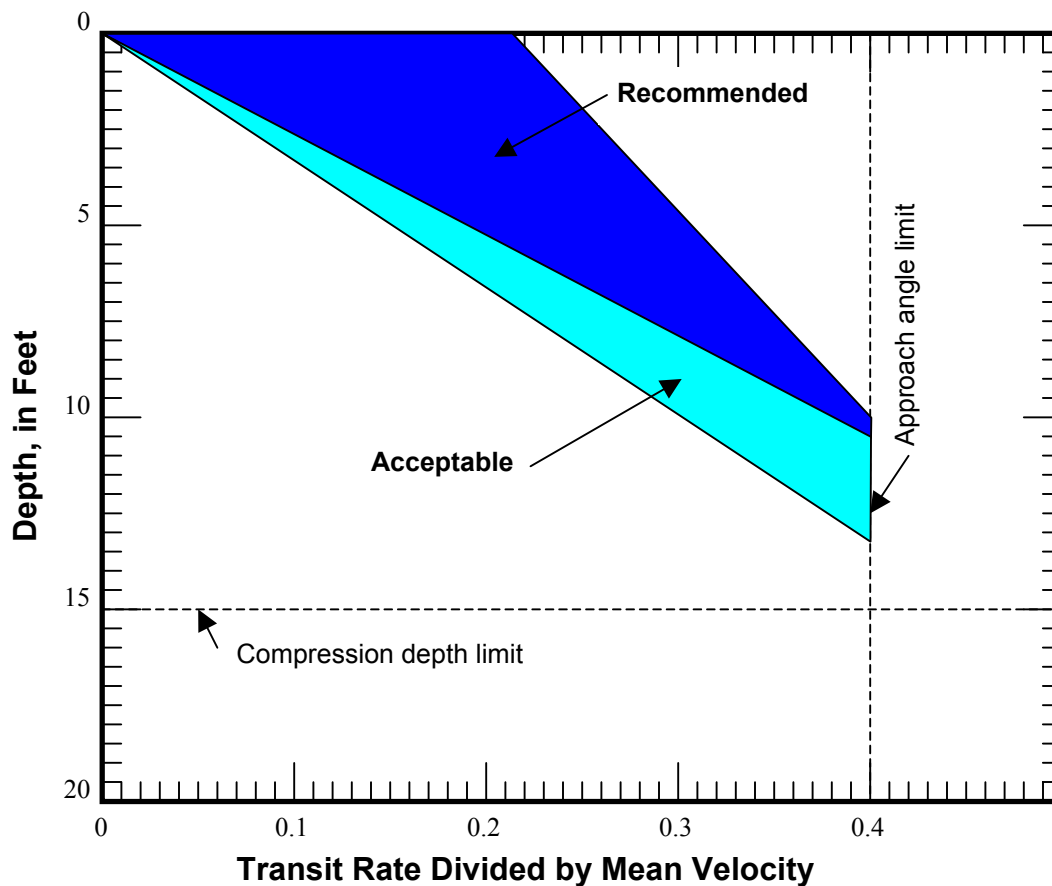
***Figure 4. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 3/16-in plastic nozzle***



Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

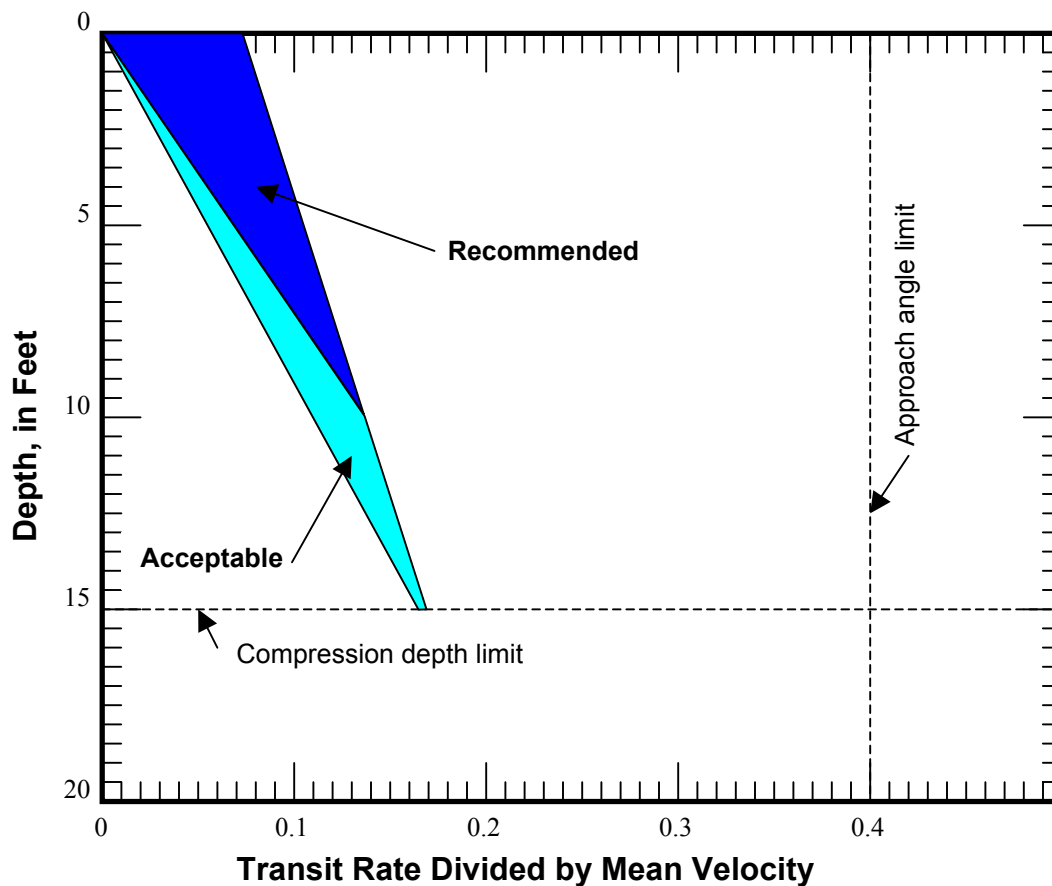
*Figure 5. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 1/4-in plastic nozzle*





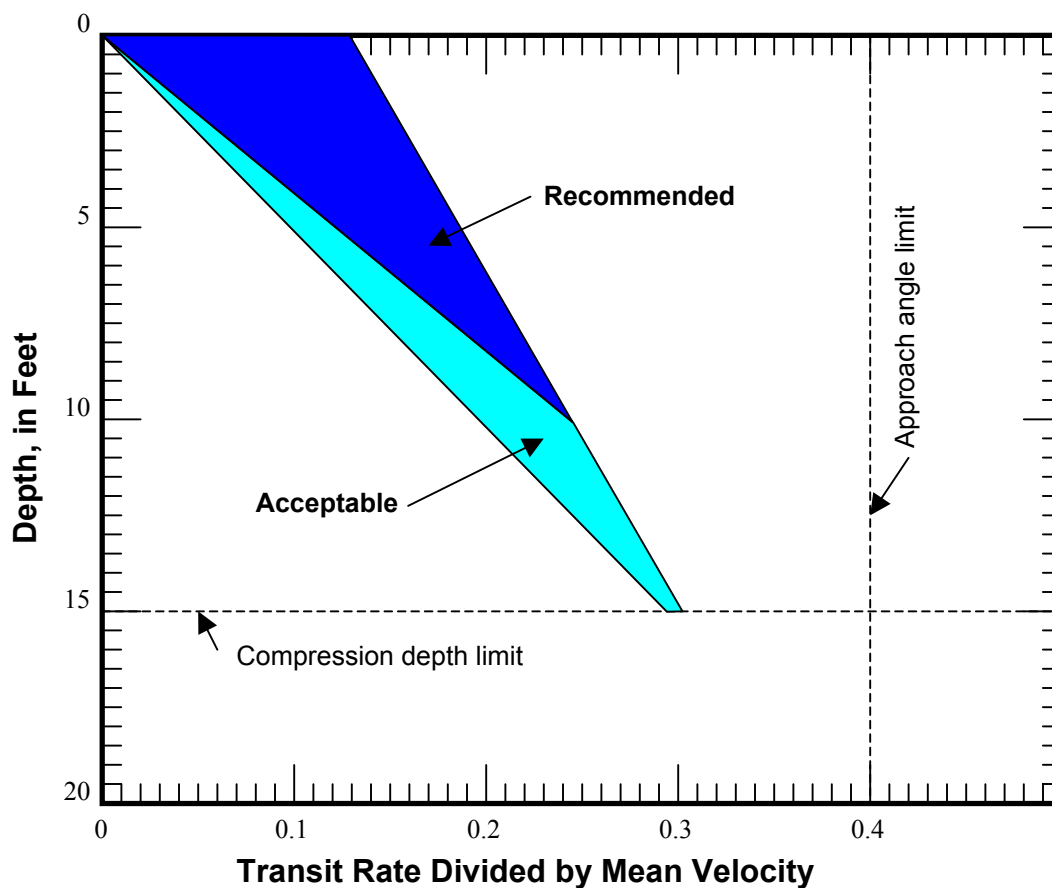
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

**Figure 6. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 5/16-in plastic nozzle**



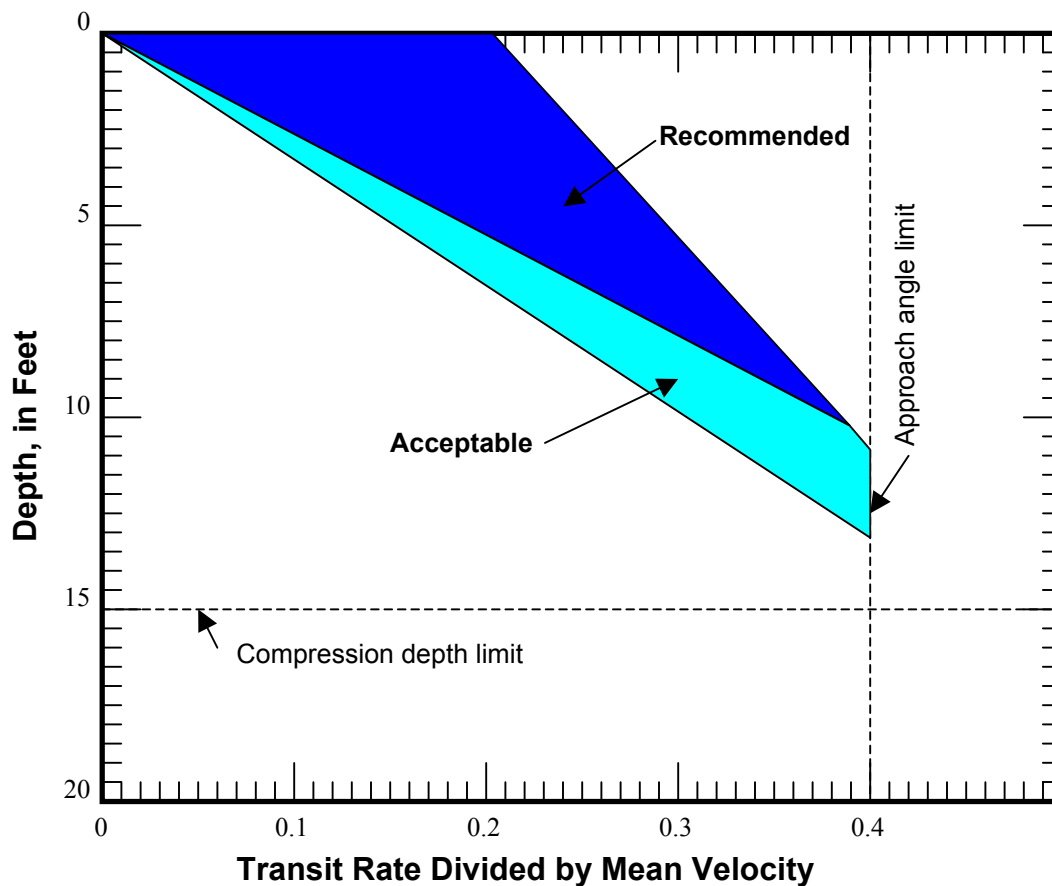
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

**Figure 7. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 3/16-in TFE nozzle**



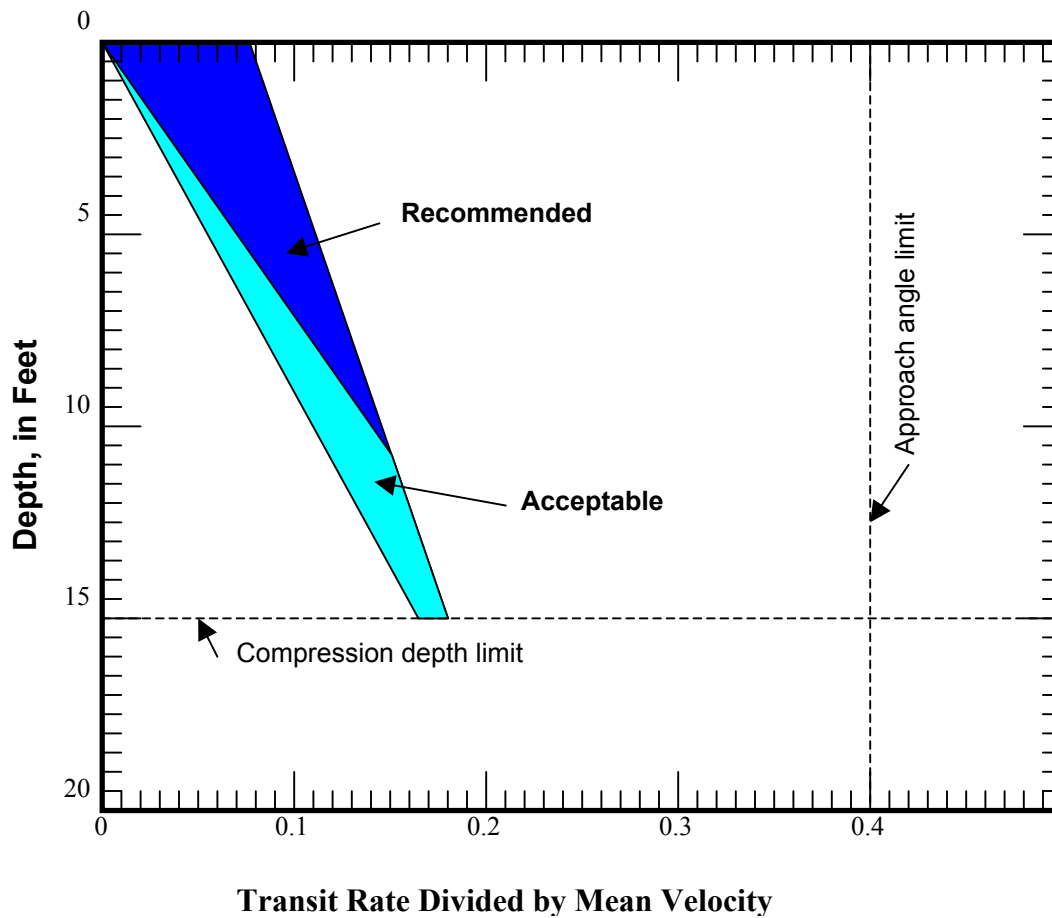
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

**Figure 8. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 1/4-in TFE nozzle**



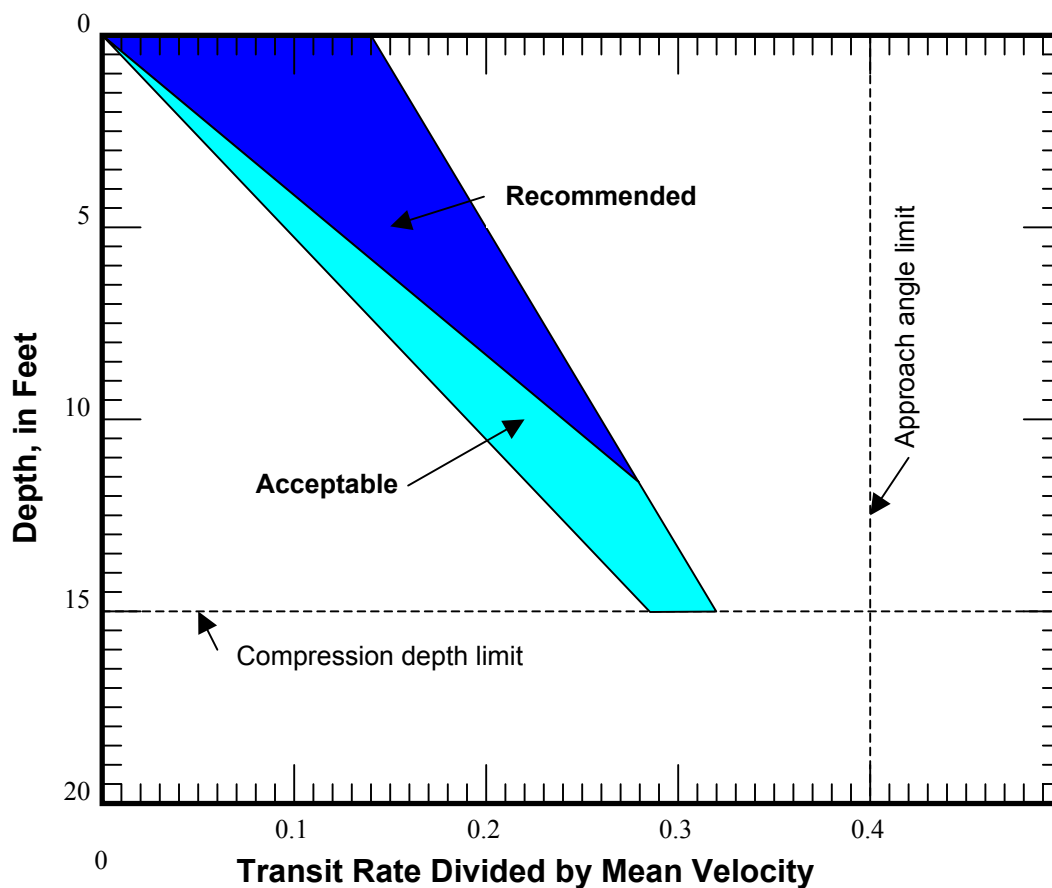
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

**Figure 9. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 5/16-in TFE nozzle**



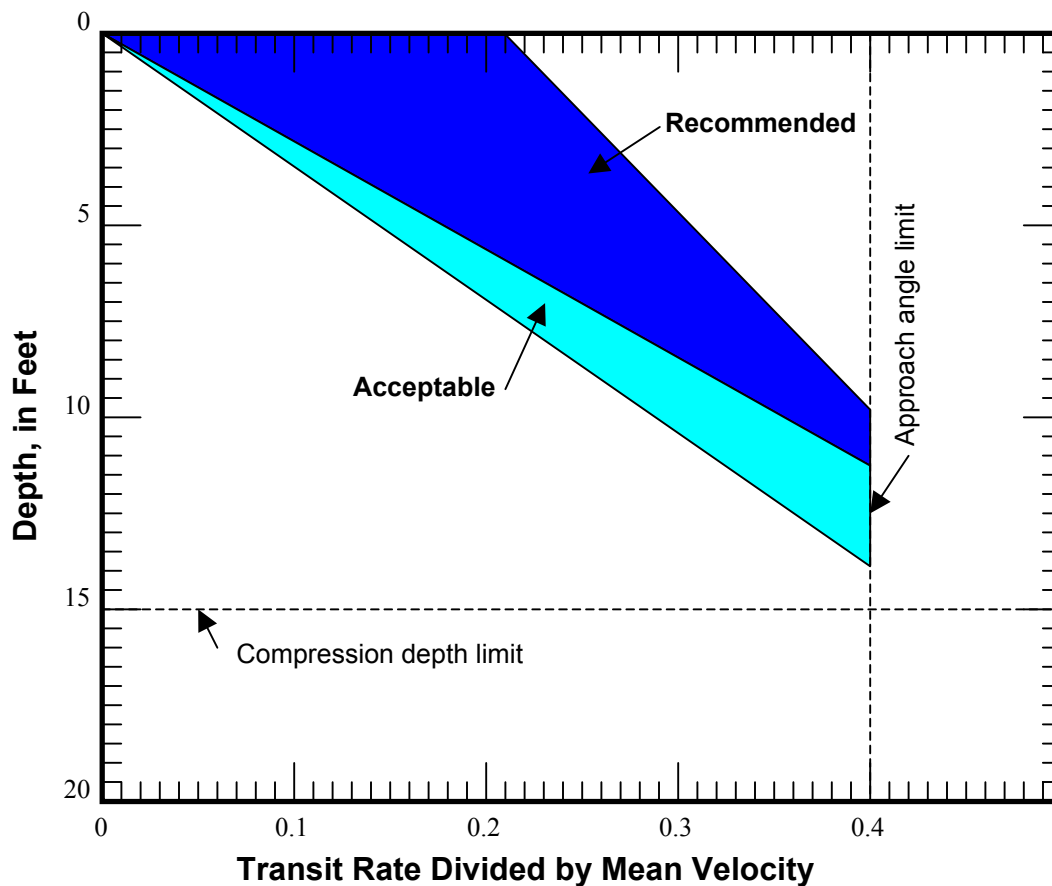
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

***Figure 10. Transit Rate Diagram for US DH-81 sampler with a US D-95<sup>TM</sup> Cap, 1-L FEP bottle, and 3/16-in TFE Nozzle***



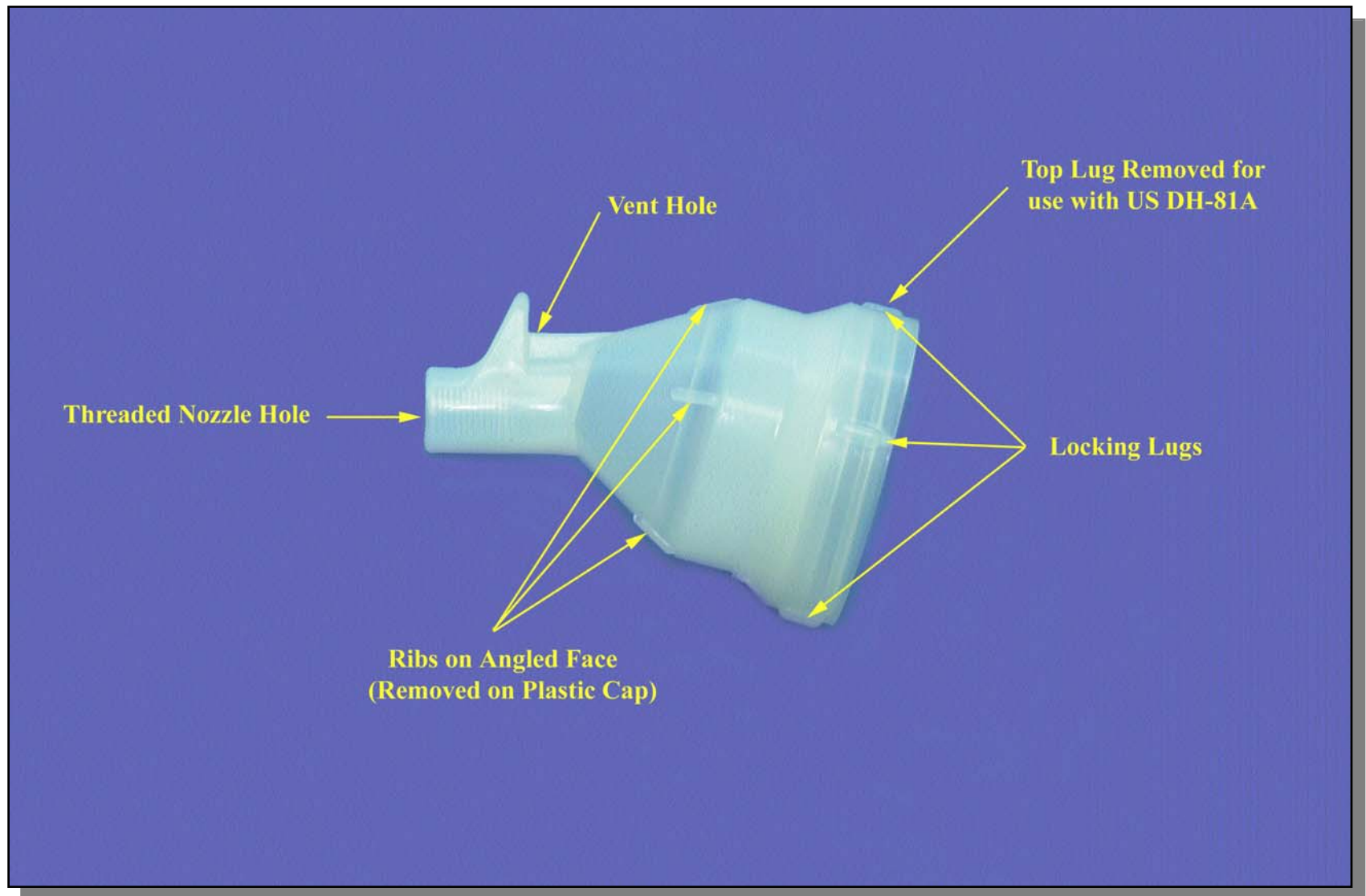
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

**Figure 11. Transit Rate Diagram for the US DH-81 sampler with a US D-95<sup>TM</sup> cap, 1-L FEP bottle, and 1/4-in TFE nozzle**



Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

**Figure 12. Transit Rate Diagram for US DH-81 sampler with a US D-95<sup>TM</sup> Cap, 1-L FEP bottle, and a US D-77 5/16-in TFE nozzle**



*Figure 13. US D-77 cap*





*Figure 14. Rear view of US DH- 81A*



*Figure 15. Example of proper position for sampling*

**Table 1. US DH-81 sampler cap/bottle combinations**

Cap	Bottle	Bottle adapter required
US D-77 Plastic	Plastic/MJT <sup>1</sup>	No
US D-77 PFA <sup>2</sup>	Plastic/MJT <sup>2</sup>	No
US D-77 PFA	FEP	Yes
US D-95 <sup>TM</sup> (TFE)	FEP	No

<sup>1</sup>MJT: Mason Jar Threads

<sup>2</sup>See page 1, Container section for explanation of PFA/plastic combination

**Table 2. US DH-81 sampler parts and part numbers**

Part	Part number
US DH-81A	002010
US D-77 plastic cap	002390
US D-77 PFA cap	002430
1-L bottle adapter	002250
US D-95 <sup>TM</sup> Cap (TFE)	001365
1-L plastic bottle	002040
1-L FEP bottle	002050
3/16 in plastic US D-77 nozzle	002270
3/16 in TFE US D-77 nozzle	002310
1/4 in plastic US D-77 nozzle	002280
1/4 in TFE US D-77 nozzle	002320
5/16 in plastic US D-77 nozzle	002290
5/16 in TFE US D-77 nozzle	002330
1 ft wading rod	002020
3 ft wading rod	002070
3 ft plastic covered wading rod	002071
1 ft wading rod extension	002030
1 ft plastic covered wading rod extension	002031
3 ft wading rod extension	002080
3 ft plastic covered wading rod extension	002081



**Table 3 -- Filling time for the US DH-81 sampler using a 1-L bottle, seconds**

Velocity, ft/sec	Volume, mL	3/16-in nozzle	1/4-in nozzle	5/16-in nozzle
1.4	800		59	
1.6	800		52	
1.8	800		46	
2.0	800	74	41	27
2.2	800	67	38	24
2.4	800	61	35	22
2.6	800	57	32	20
2.8	800	53	30	19
3.0	800	49	28	18
3.2	800	46	26	17
3.4	800	43	24	16
3.6	800	41	23	15
3.8	800	39	22	14
4.0	800	37	21	13
4.2	800	35	20	13
4.4	800	33	19	12
4.6	800	32	18	12
4.8	800	31	17	11
5.0	800	29	17	11
5.2	800	28	16	10
5.4	800	27	15	10
5.6	800	26	15	9
5.8	800	25	14	9
6.0	800	25	14	9
6.2	800	24	13	9
6.4	800		13	8
6.6	800		13	8
6.8	800		12	8
7.0	800		12	8
7.2	800		12	
7.4	800		11	
7.6	800		11	